Rusty Monitor (*Varanus semiremex*) from Rockhampton district.
(Photo: R. Jackson). See article on page 15.

The Red-Faced Turtle, *Emydura victoriae*, from the Daly River, showing macrocephalic condition.
See article on page 11.

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HERPETOLOGICAL NOTES

DIURNAL FORAGING AND BASKING BY THE DIPLODACTYLINE GECKO *STROPHURUS SPINIGERUS SPINIGERUS* (GRAY, 1842) IN A *GREVILLEA* SHRUB IN AN URBAN BACK YARD, WITH NOTES ON REPRODUCTION AND THE BODY DIMENSIONS AND COLORATION OF A JUVENILE

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Strophurus spinigerus spinigerus is a common gecko associated with the south-west Australian coastal strip between Shark Bay and Mandurah, particularly where *Acacia rostellifera* occurs; however there are scant details of behaviour and reproduction. The following diurnal observations were recorded between July and November 1994 (winter to late spring) on a group of *Strophurus s. spinigerus* that once occurred in the urban back yard of the premises occupied by the first author in 1994, at 45 Jameson St, Mosman Park, Perth, Western Australia, at 32°01'01"S, 115°46'16"E, 25 m elevation (Magellan GPS 315, WSG84 grid). Most observations were made between *ca.* 1130-1330 hrs. All individuals in the colony occupied an isolated, single shrub of a non-autochthonous species of red-flowering (winter) *Grevillea* sp. The shrub was *ca.* 1.5 m in both height and diameter, and old and densely shrubby with many dead branches and much litter underneath. It was situated off-centre in the middle of the back yard amidst sparse lawn, away from peripheral introduced exotic shrubs and trees. The *Grevillea* attracted many insects to its flowers, and this may explain the tenancy of the group, which consisted of three adults and five juveniles. All individuals were observed basking on sunny days during the winter months, near the crown. Often the juveniles were observed, and the adults were not. When juveniles and adults were observed together, the juveniles occupied slightly lower branches in the crown than the adults. This may be evidence of a size-based hierarchy for favoured basking sites, although aggressive interactions were not observed. This is the first record of basking in a western species of *Strophurus*, although it has previously been

reported for the south-eastern *S. intermedius* (Ehmann, 1980 (as "perching"); Sass, 2003 (as "probable...basking behaviour")). Our observations also demonstrate winter activity. Both adults and juveniles were observed chasing flies and small microlepidoptera (moths) during the day, mostly in the crown of the shrub 1.3-1.5 m above ground; however, no captures were observed.

On 24 August 1994, 1000 hrs, a juvenile was captured, measured and colour notes taken; it was then released. Measurements were snout-vent length (SVL) 34 mm, tail length (TL) 23.5 mm (original whole tail). The lizard had blue surfaces in the mouth, a dark grey tongue, a yellow periphery of the iris, venter with fine black peppering (spots) on grey background and no indication of stripes, and tail spines black. On the morning of 16 November 1994, at *ca.* 0900 hrs, a gravid female was found dead below the shrub, having died from unknown causes overnight. It measured SVL 70 mm and TL 40 mm (regenerated broken tail). Dissection revealed two near full-term eggs *ca.* 16 mm long by 9 mm maximum diameter (one in each oviduct), plus two enlarged follicles 5.75 mm in diameter; this suggests double clutching in this species. This accords with the record of Chapman and Dell (1979: 118, 125) for a female *Strophurus spinigerus inornatus*, SVL 70 mm, collected in November from East Nugadong Reserve, which had the same egg size (length 16 mm). Dell and Chapman (1977: 77) report all *Strophurus s. spinigerus* females collected in October from Cockleshell Gully Reserve of greater than 60 mm SVL were gravid, with three specimens having 2/2, 0/1, and 2/1 oviducal eggs respectively; where there were two eggs in an oviduct, the

second was half the size of the first, which "indicates intervals between laying"; mean female SVL was 59.3 mm, mean male SVL 51.7 mm; a juvenile was recorded in May (no dimensions given). Bush *et al.* (1995) give dimensions of soft-shelled eggs as "16 mm long and 12 mm wide", and hatchlings as measuring 20 mm SVL. They also report that this species has been observed resting on the wire of weldmesh gates by day. Bush (1981) reports neonates of *Strophurus spinigerus inornatus* measuring "4 cm overall length".

Unfortunately, the observations at the Mosman Park locality cannot be repeated, since a recent visit to the site by the first author indicated that the shrub microenvironment is no longer extant.

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FORAGING BEHAVIOUR AND A POTENTIAL DIETARY RECORD, AND THE SOUTHERN MOST RECORD IN WESTERN AUSTRALIA, FOR *PYGOPUS NIGRICEPS* (FISCHER, 1882) (SAURIA: PYGOPODIDAE), WITH A REVIEW OF PREDATORY TECHNIQUE AND DIET IN THE GENUS

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On 3 December 1979, 2030 hrs, 8 km south of the Dandaraga - Menzies road junction on Menzies Road (near Elspon Well, Western Australia), at 28°17'S 119°40'E, on a red sand plain with *Triodia basedowii*, an adult *Pygopus nigriceps* was detected by the second author while undertaking a herpetological biodiversity survey using head-torching. The specimen was observed for *ca.* three minutes in continuous pursuit of an adult lycosid spider, *Lycosa tula*. It did not succeed in capturing the spider due to disturbance by the observer. This is the first record of the identity to species level of any dietary item of wild *P. nigriceps*. It is notable that the lizard was trying to capture an active spider, rather than one located in a burrow. The only other reptile observed at this site on this occasion was one active adult gecko, *Rhynchoedura ornata*.

Patchell and Shine (1986) report that *P. nigriceps* feeds on insects (27 individuals in 27 specimens), scorpions (one individual in one specimen) and araneamorph spiders (four individuals in three specimens), but not lizards, whereas *Pygopus lepidopodus* is predominately a spider feeder which also takes insects and scincid lizards, but never scorpions. Pianka (1986) reports the stomach contents of 18 *P. nigriceps* as consisting of 37.8% unidentified arthropods, 34.3% scorpions, 25.8% spiders and 2.1% ants (by volume). *Pygopus nigriceps* has recently been divided into three species (James et al., 2001). The species identity of the material examined by Patchell and Shine (1986) and Pianka (1986) is uncertain, although on the basis of his known field sites, the latter author probably worked with *P. nigriceps*. A colour photograph by Densey Clyne in Vandenbeld (1988:174

lower) is of a *Pygopus*, most closely matching *P. nigriceps*, with a large lycosid spider of unknown identity in its mouth; the provenances of pygopod and spider are not stated. The text accompanying the photograph describes a motionless lie-in-wait and rapid-strike predatory technique at variance with the continuous-pursuit technique described above, and also states that "*Pygopus* occasionally renders its victim immobile by biting off the legs before it consumes the body", both of which suggest technique variability, as does the following observation. Husband (1980) records an unusual rapid body twisting behaviour along the long axis in a captive *Pygopus lepidopodus*, perhaps (in the opinion of that author) excavating a burrow, perhaps (as suggested by Greer, 1989) to obtain burrow-inhabiting spiders which have been reported as the major component of the diet of this species (Patchell & Shine, 1986). A third alternative, suggested here, is that the purpose of this behaviour is to facilitate the disabling of potentially harmful spider prey items, or to disarticulate arthropod prey into smaller sizes for swallowing. It would be interesting to know whether this body-twisting behaviour also occurs in the case of *P. nigriceps* predation in the wild on spiders and on scorpions, particularly burrow-inhabiting *Urodacus* scorpions.

Our contention is supported by the captive observations in November 1979 of Philipp (1980) who reports a *P. nigriceps* (as "*nigreps*") utilising rapid body twisting behaviour along the long axis ("two or three times") in a series of predatory assaults on a large (80 mm) *Urodacus novaehollandiae* (presumably free-roaming rather than initially situated in a burrow). The pygopod was undeterred

by repeated separation of protagonists (five times), close presence of observer, and "dim light and numerous photo-flashes", until the scorpion was rendered immobile (after ten minutes of observation), when the lizard was observed to lap body fluid exuding from injuries to the abdomen of the scorpion, and then drag it under a log. The following morning, the exoskelton was found void of body fluid and with urosoma detached, apparently with parts of the abdomen and some legs missing. If predation by *P. nigriceps* on large arthropods of similar size to this *U. novaehollandiae* occurs with a high frequency in the wild, and similar body-fluid-only feeding occurs, such dietary components would not be detected in studies based on analysis of exoskeletal gut-contents alone. Disarticulation of arthropod prey (in this case freshly-moulted, soft-shelled grapsid crabs) to facilitate swallowing has been reported in the homalopsine snake *Gerardia prevostiana* (Jayne *et al.*, 2002; Murphy & Voris, 2002).

Four predation techniques have thus far recorded in *P. nigriceps*; selection of a particular technique appears to be influenced by size, type, and proximity of the prey. The four techniques are not necessarily all mutually exclusive and some may represent elements in a sequence.

Philipp (1980) also reports apparent captive predation on *Lerista elegans*, which indicates the dietary range of *P. nigriceps* reported by Pianka (1986) and Patchell and Shine (1986) may be expanded to include small scincid lizards, as is the case with *P. lepidopodus*.

On 26 September 1996, 1300-1430 hrs, three adult *Pygopus nigriceps* were collected from under discarded sheets of building iron near Mount Palmer cemetery, at 31°24'S 119°40'E. The topography, vegetation and substrate components of the habitat at this site vary. The sequence is Salmon Gum woodland on yellow-pink sandplain that merges with mallee/gimlet woodland (*Eucalyptus* spp.), both woodland types on slightly higher ground; the latter is replaced by a *Thryptomene* scrub zone in a slight depression with scattered exposed flat sheet metamorphic granite areas more or less flush with the adjoining soil surfaces. An understory of scattered *Triodia scariosa* hummocks on yellow to yellow-orange granitic clay/sand substrates occurs in the latter two dominant vegetation zones. One *Pygopus* was found under a discarded sheet of building iron at the *Thryptomene*/woodland interface, while the other two were found under another sheet of building iron on bare soil in scrub/woodland; a photograph of one of these specimens is in Figure 1.

Together with the Goomalling and Yorkrakine records cited in Storr *et al.* (1990:130), these comprise the southern limit, and this observation is the most southerly record, for this species in Western Australia. Other reptile species detected on this occasion at this site within the same patch of habitat were the agamid lizards *Ctenophorus cristatus* and *Ctenophorus scutulatus*, the geckos *Crenadactylus ocellatus, Diplodactylus granariensis, Gehyra variegata, Heteronotia binoei* and *Underwoodisaurus milii*, the skinks *Cryptoblepharus* cf. *plagiocephalus, Egernia inornata, Hemiergis initialis, Lerista* cf. *muelleri, Menetia greyii* and *Morethia butleri*, and the elapid snakes *Parasuta gouldii* and *Pseudonaja modesta*.

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Figure 1. *Pygopus nigriceps* from near Mt Palmer Cemetery (Photo: G. Shea)

HERPETOFAUNAL ASSEMBLAGES UTILISING ABANDONED STICK-NEST ANT (*IRIDOMYRMEX CONIFER*) NESTS AS REFUGIA

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The nests of Stick-nest Ants, *Iridomyrmex conifer* (Hymenoptera: Formicidae), are mainly constructed in white sandy country at swamp margins that are dry and not inundated. They may be occupied by ants (determined by tapping the top of the nest), or unoccupied (the ants move to construct new nests and do not stay in the one for very long, sometimes remaining for as little as a few months) but have other possible invertebrate, amphibian, and particularly reptilian inhabitants. The mounds may be as high as 15 cm and chambers below ground not much more than 30 cm depth with an internal diameter of 10-15 cm, and are therefore easy to totally excavate. The nest of the ant is predominantly comprised of *Allocasuarina fraseriana* needle litter, occasionally *Melaleuca* sp. leaf litter, or rarely that of other plant species; a photograph taken by the first author of a Stick-nest Ant nest is given in Shine (1986: 437) and a colour photograph taken in April 1979 of a nest at Bunkers Bay turn off, Cape Naturaliste, WA, is on the upper back cover of the current issue of this journal. Abandoned nests are chosen by reptiles because they are warm; they are elevated and hence not subject to seasonal flooding, and they have narrow entrances and thus exclude larger vertebrate predators. They are utilised by some species during the winter months as "hibernaculae" or, at least, refugia, during their winter dormancy, and by other species during the warmer months as permanent homesites or temporary refugia.

The following list of 26 species of herpetofauna found in *I. conifer* nests is compiled from the collated field records of the first author: *Pseudophryne guentheri* (Myobatrachidae), *Tympanocryptis adelaidensis* (Agamidae), *Delma fraseri*, *Lialis burtonis* (Pygopodidae), *Acritoscincus trilineatum*, *Ctenotus catenifer*, *Ctenotus gemmula*, *Ctenotus impar*, *Glaphyromorphus gracilipes*, *Hemiergis quadrilineatum*, *Hemiergis peronii peronii*, *Lerista elegans*, *Lerista lineata*, *Lerista microtis*, *Lerista praepedita*, *Menetia greyii*, *Morethia lineoocellata*, *Tiliqua occipitalis* (Scincidae), *Ramphotyphlops australis* (Typhlopidae), *Brachyurophis semifasciatus semifasciatus*, *Demansia reticulata*, *Neelaps calonotus*, *Simoselaps bertholdi*, *Parasuta gouldii*, *Pseudonaja affinis*, *Rhinoplocephalus bicolor* (Elapidae). Other species encountered include macroinvertebrates such as scolopendrid centipedes, mygalomorph and lycosid spiders, occasional *Urodacus novaehollandiae* scorpions (probably stranded during foraging), terrestrial beetles (Scarabeidae: Dynastinae; Cuculionidae: Amycterinae; Tenebrionidae: Heleini) and their larvae, and a variety of microinvertebrates. The nests of *I. conifer* are therefore a significant habitat component for small to medium sized herpetofaunal species and for terrestrial invertebrates.

The species composition of herpetofaunal assemblages found in nests varies across the *I. conifer* distribution, based on soil-type and annual precipitation. Relative frequency of encounter also varies. Herpetofauna were recorded in nests from six general localities (north to south):

1. Melaleuca Park, WA (just outside the Perth metropolitan area), at 31°41'S 115°54'E, habitat *Banksia menziesii*-dominated woodland with heath understorey on white siliceous Bassandean sands.

2. Karawara, WA (Perth suburb), at 32°00'S 115°52'E, habitat *Banksia menziesii*-dominated woodland with heath understorey on white siliceous Bassandean sands; habitat no longer extant due to extensive anthropogenic disturbances associated with urbanisation.

Table 1. Species, numbers and age class (first figures are totals, in brackets n = neonate, j = juvenile, +j = includes juveniles, s = sub-adult; remainder adult), and localities for amphibians and reptiles recorded from abandoned *Iridomyrmex conifer* nests.

	Melaleuca Park	Karawara	Gosnells	Singleton Beach	Betty's Beach	29 km E Denmark
Pseudophryne guentheri		2				
Tympanocryptis adelaidensis		1				
Delma fraseri	1	common (+j)				
Lialis burtonis		1 (1j)				
Acritoscincus trilineatum		1			2	
Ctenotus catenifer						1
Ctenotus gemmula	1	1 (1s)				
Ctenotus impar			1 (1s)			
Glaphyromorphus gracilipes					3	
Hemiergis quadrilineatum		3		1		
Hemiergis p. peronii					1	
Lerista elegans		7 (2j)				
Lerista lineata				1		
Lerista microtis						1
Lerista praepedita	2					
Menetia greyii		numerous (+j)				
Morethia lineoocellata		numerous (+j)				
Tiliqua occipitalis		1 (1n)				
Ramphotyphlops australis		1 (1j)				
Brachyurophis s. semifasciatus		1				
Demansia reticulata				1		
Neelaps calonotus	1					
Simoselaps bertholdi	1					
Parasuta gouldii		abundant (+j)				
Pseudonaja affinis		1 (1j)				
Rhinoplocephalus bicolor					7 (4j)	
TOTALS (26 spp.)	6	>20 (1n, 1s,>4j)	1 (1s)	3	13 (4j)	2

3. Gosnells, WA (Perth suburb), at 32°05'S 116°00'E, habitat *Banksia menziesii*-dominated woodland with some emergent Marri (*Corymbia calophylla*) and Jarrah (*Eucalyptus marginata*) and a heath understorey, on swampy substrates comprised of a mixture of white siliceous Bassandean sands and grey clay soil.
4. Singleton Beach, WA (South of Mandurah) at 32°24'S, 115°45'E, habitat *Acacia/Lepidosperma/Olearia/Scaevola* coastal scrub/ heath, on white calcareous sand.
5. Betty's Beach, Two People Bay, WA (south coast), at 34°56'S 118°12'E, habitat stunted *Eucalyptus/Corymbia* spp. woodlands with heath and sedge understorey on swampy grey/white fine clay soil.
6. 29 km east of Denmark, WA (south coast hinterland), at 34°59'S 117°40'E, habitat *Melaleuca preissiana* swamp with sedge understorey on fine grey soil.

Table 1 collates species and numbers of herpetofauna in abandoned nests at these sites.

DISCUSSION

Abandoned nests of the *I. conifer*, appear to be a unique refugium type, both in Australia and at a world level; the large number of reptile species thus far recorded from them demonstrates their value as refugia. As mentioned, this is mostly attributable to the warm, dry, elevated, narrow-entranced nature of these nests, but may partly be due to the fact that most predators in Australia avoid ants and their nests, which may extend some protection from predator investigation to abandoned nests of *I. conifer*.

The above results provide an indication of relative abundance, and the numbers and ecological diversity of the species thus far detected in abandoned *I. conifer* nests, comprising one myobatrachid frog, one agamid, three pygopodids, fourteen scincids, one typhlopid, and seven elapid species; it is possible that further investigation will extend this list. That only a single amphibian species, *Pseudophryne guentheri*, was detected is somewhat surprising given the large number of small terrestrial species of the myobatra-

chid genera *Crinia* and *Geocrinia* and larger burrowing species of the genera *Heleioporus* and *Neobatrachus* whose distributions overlap that of the ant, although large body size may exclude the latter two genera from nest entrances, or more probably they prefer to excavate their own burrows rather than utilising ready-made refugia such as abandoned ant nests. The groups best represented in nests are Scincidae (14 spp.) and Elapidae (7 spp.), unsurprisingly, as these are the two most speciose Australian families; *Lerista* is the best represented genus (4 spp.), followed by *Ctenotus* and *Hemiergis* (3 and 2 spp. respectively); all other genera are represented by single species. Varanidae and Pythonidae are unrepresented and probably excluded from these refugia by large body size. Gekkonidae are notable by their absence from *I. conifer* nests, perhaps because their large body diameters exclude them from nest entrances, although the neonate *Tiliqua occipitalis* and the adult *Tympanocryptis adelaidensis* had body diameters of equivalent or greater size to many of the gecko species found across the distribution of *I. conifer*; the thin delicate skins of geckos may possibly be an exclusion factor. The reasons for apparent exclusion of this family are unknown but worthy of further study. It is possible that the upper size limit of snakes that can occupy these nests is approximately that of an adult *Demansia*, *Parasuta*, or *Rhinoplocephalus* species.

There was very little overlap in assemblages detected in abandoned nests at the six sites; only three species were detected at more than one site: *Delma fraseri* and *Ctenotus gemmula* (Melaleuca Park and Karawara), *Hemiergis quadrilineatum* (Karawara and Singleton Beach), and *Acritoscincus trilineatum* (Karawara and Betty's Beach). *Ctenotus gemmula* is a discontinuously distributed, uncommon species that is poorly known, and its record in *I. conifer* nests at these localities represents a major proportion of the published biology of the species and may be significant, particularly since the Karawara habitat and most endemic biota that occurred there is extinct, whereas the two other species are more wide ranging and common in the

south-west of Western Australia and have distributions approximating that of the ant. However the predominately diurnal (M.P. pers. obs.) *D. fraseri* is recorded in nests from only the northern Perth area localities, and the heliothermic *A. trilineatum*, which occupies similar elevated swamp margin habitat to the ant, was recorded in nests from widely separated northern and southern localities in its range. The largely discrete faunas at most sites reflect limited northerly or southerly herpetofaunal distributions overlapped by the more wide ranging ant.

By far the largest herpetofaunal assemblage detected in nests was at Karawara, undoubtedly partly due to greater frequency of survey at this locality, conducted over many years prior to its destruction with urban sub-division, but also due to a high density of *Iridomyrmex conifer* nests, and perhaps also some feature of the habitat such as soil type or moisture content which favours stick-nest ant presence, or features of the habitat that favour a high reptile biodiversity, coincident with stick-nest ant presence in a high density. Three localities, Gosnells, Singleton Beach, and 29 km east of Denmark, had one, three and two species records, respectively, reflecting lower survey effort, lower density of stick-nest ant nests at these sites, and in the latter case a lower potential herpetofaunal diversity available in the area to exploit abandoned nests as refugia.

In terms of relative abundance, the most frequently detected species were *Parasuta gouldii* (abundant), *Menetia greyii* and *Morethia lineoocellata* (numerous), *Delma fraseri* (common), and *Lerista elegans* and *Rhinoplocephalus bicolor* (several), all present as both adult and juveniles, occasionally found together in nests in the case of the latter species (see Shine, 1986).

12 species (46.15%) were found as younger (neonate, juvenile, sub-adult) than adult age class. Abandoned ant nests would opportunistically suit juveniles seeking scarce refugia in which to establish themselves, which may explain the high number of species and individuals found as juveniles.

The frog and 11 of the 25 reptile species detected in nests are fossorial/subterranean, and a further two reptile species, *Parasuta gouldii* and *Rhinoplocephalus bicolor*, are cryptic nocturnal terrestrial forms with well developed burrowing capability in loose materials and readily enter tunnels previously excavated by other animals; six of these burrowing species were found as juveniles. Vacated ant nests of this structure and size provide suitable refugia for burrowing species, as evidenced. Of total species detected in nests, 12 were diurnal, 14 nocturnal (*Delma fraseri* here treated as diurnal, as is *Lialis burtonis*); reasons for this preponderence are unknown, there is a strong association of these nocturnal species with fossorial habits.

Future longitudinal studies may indicate the extent to which abandoned nests are utilised as refugia for spring-summer active species, and as winter hibernaculae, or both. The above records are a collation of species from a number of abandoned nests over extended repeat survey, not simultaneous detection in a single nest at each locality (only single species have been found in each nest, all single individuals except for three *R. bicolor* in one nest at Betty's Beach), therefore future studies could include, for each habitat-type (soil and vegetation) and region, a census of the number of *I. conifer* nests, the number occupied by their builders, and then systematic survey of abandoned nests for amphibian and reptile diversity and abundance; it would also be interesting to search several occupied *I. conifer* nests to determine if these are also utilised by any species as refugia.

ACKNOWLEDGMENTS

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FIRST GLIMPSES INTO THE ECOLOGY OF THE RED-FACED TURTLE, *EMYDURA VICTORIAE*, IN TROPICAL AUSTRALIA

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Comparisons of the life histories of reptiles are often hindered by persistent knowledge gaps for many species, both worldwide and in Australia (Shine, 1985). An example is our poor knowledge of the reproductive ecology of turtles in the Australian tropics (see Cann, 1998). One species that is particularly poorly understood is the Red-faced Turtle, *Emydura victoriae* (Fig. 1), an inhabitant of the Top End, Northern Territory and surrounding areas (Cann, 1998). Almost nothing is known of its reproductive life history, including when and where females nest, and the available information is suspect due to taxonomic problems that have only recently been resolved (Georges & Adams, 1996). Herein, we provide anecdotal reproductive data for female *E. victoriae* from the Daly River, Northern Territory, collected opportunistically during ecological studies of the pig-nosed turtle, *Carettochelys insculpta* (Doody, 2002). We also provide size structure data, stemming from a comparative dietary study (Welsh, 1999).

Data were collected during the dry season (July-October) near Oolloo Crossing on the Daly River, NT. Reproductive data were collected in 1996, and size structure data were collected in 1998 as part of an Honours project (Welsh, 1999). Turtles were captured with dip nets from a boat (usually at night), and were measured, weighed, and released within 24 hours. Turtles were identified as *E. victoriae* by the presence of greatly expanded triturating surfaces in the mouth that formed distinct crushing plates. Sex was determined by examination of the position of the cloaca relative to the rear carapacial edge (in males the cloaca is distal to the carapacial edge). A

Figure 1. A female *Emydura victoriae* from the Daly River, showing macrocephalic condition.

few females were x-rayed opportunistically for the presence of eggs using a portable x-ray machine (ExcelRay®), and radiographs were developed in a makeshift darkroom (trailer). Eggs in radiographs were counted to determine clutch size, but egg sizes could not be quantified due to the different positions of the ellipsoid eggs within the oviducts, relative to the plane of the radiograph. Nesting crawls and a clutch of eggshells (preyed upon by goannas) were found opportunistically.

We captured and measured 156 E. victoriae, of which 78 were males and 78 were females. Female-biased sexual size dimorphism is evident from the size structure data (Fig. 2), a pattern observed in most chelid turtles (Ernst & Barbour, 1989). Table 1 shows available reproductive data for several female E. victoriae. Some data were not collected for some individuals. Based on radiograph data, clutch size was 8.7 ± 2.16 eggs for six individuals (other animals were not x-rayed). We discovered 14 E. victoriae nesting crawls across several beaches in late September and early October (Table 2). We assumed that these were nesting crawls because to our knowledge Emydura do not generally leave the water except to nest or to seek more permanent water (Cann, 1998), and so the latter would not apply. We could find no nests asso-

ciated with these crawls because they led to vegetated areas where tracks were no longer discernable. However, it is likely that these were E. victoriae crawls because (1) their appearance coincided with E. victoriae being gravid based on radiograph data (2) they were too small to be C. insculpta, and (3) the other common, syntopic species nest during the wet season or early dry season (Chelodina rugosa, Elseya dentata, Cann, 1998). We did, however, find one E. victoriae nest (eggshells) on 14 October 1996 that was destroyed by a goanna, as evidenced by tracks. Although species identification was not possible at the time of finding the eggshells, x-ray data from gravid females coincided with their discovery, and the other common species at the site either lay round, hard-shelled eggs (Carettochelys) or nest during the wet season or early dry season (Chelodina, Elseya). The nest was among ferns along the riverbank, in loamy sand.

It appears that E. victoriae nest during the dry season. Legler (1985) reported that NT Emydura nest between late August and early November but offered no data, and the species he is referring to is in doubt. However, Cann (1998) could find no gravid E. victoriae by palpation during 6-25 September. Our data were not sufficient to accurately delin-

Figure 2. Size structure of the *E. victoriae* population from the Daly River near Oolloo Crossing, NT. CL = carapace length.
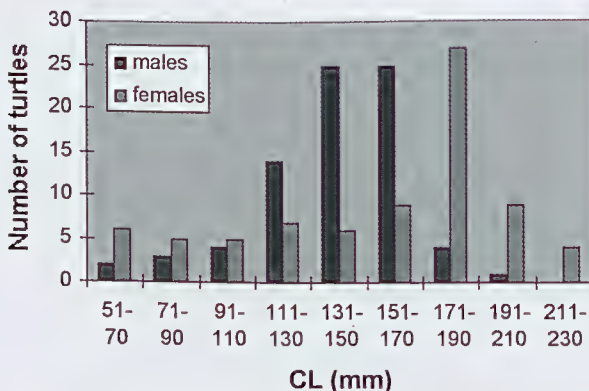
Table 1. Clutch size and rough timing of nesting for *E. victoriae* from the Daly River during 1996. CL = carapace length, PL = plastron length, n/a = data not collected.

turtle #	marked	CL (mm)	PL (mm)	mass (g)	x-ray date	clutch size
1	35	212.8	171.6	1350.3	17 Sept	11
2	43	170.2	140.7	812.8	26 Sept	10
3	44	170.9	141.2	699.9	26 Sept	6
4	40	n/a	n/a	n/a	n/a	9
5	41	n/a	n/a	n/a	n/a	10
6	n/a	n/a	n/a	n/a	n/a	6

eate the nesting period, but nesting apparently occurs at least during mid-September to mid-October.

Although our anecdotal observations prevented determination of clutch frequency in the population, we can infer three possibilities from the knowledge of the nesting season of another dry season-nester at the site, *C. insculpta* (Doody *et al.*, 2003a), and the timing of wet season flooding at the site (Doody *et al.*, 2001). The first possibility is that *E. victoriae* nest only once during the middle of the dry season. This is unlikely given the general trend of multiple clutches produced annually in tropical reptiles (Fitch, 1981; Legler, 1985), unless there is some energy problem in the population. However, because the species eats mainly molluscs at the site (Welsh, 1999), energy is not likely to be particularly limiting (compared to a herbivorous species; see Doody *et al.*, 2003b). A second possibility is that two clutches are laid and we sampled the second clutch, which, like in *C. insculpta* is deposited in time to facilitate hatching and emergence prior to wet season flooding (beginning in late November, see Doody *et al.*, 2001, 2003a,b). The third possibility is that two clutches are laid, and we sampled the first one. This is unlikely unless the species exhibits embryonic diapause (Ewert, 1985), because the second clutch would almost certainly be

Table 2. Timing of crawls of *E. victoriae* in search of a nest site along the Daly River in 1996.

date observed	# of crawls	#of beaches
24 Sept	2	1
27 Sept	2	1
29 Sept	2	1
30 Sept	5	4
2 Oct	2	2
3 Oct	1	1

flooded if the eggs were deposited near the river's edge (as found above). Among Australian turtles, embryonic aestivation, defined as delayed hatching after completion of embryonic development, is known only in *C. insculpta* (Webb *et al.*, 1986; Doody *et al.*, 2001).

A more rigorous study of the spatial and temporal components of nesting in *E. victoriae* is needed, including research into the possibility that the species possesses embryonic diapause. We hope this note will facilitate such research.

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Note added in proof

Smith and Wood (1985) found a single *E. victoriae* nest with hatchlings under leaf litter among *Pandanus* roots on 21 September along the McKinlay River. The nest was approximately 3 m from water and 1.5 m above water. The nest was likely laid in August, based on a typical turtle incubation period of 60-75 days. Their larger clutch size (16-17) than that of our turtles may have been related to variation in female body size. Smith, A. M. A. and T. C. Wood. 1985. A nest and hatchlings of *Emydura victoriae* (Gray, 1842). Northern Territory Naturalist 8:15.

THE POORLY KNOWN RUSTY MONITOR *VARANUS SEMIREMEX*: HISTORY, NATURAL HISTORY, CAPTIVE BREEDING AND HUSBANDRY

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INTRODUCTION

The Rusty Monitor, *Varanus semiremex*, was described in 1869. Despite this species being recognized for so long, little is known about it in the wild or captivity and it is regarded as one of Australia's many poorly known reptile species (Cogger *et al.*, 1993; Bennett, 1995). Captive specimens of *V. semiremex* have been held in the last 30 years in Germany, the United States of America and Australia. However, no detailed observations have been published on its breeding habits and maintenance. *Varanus semiremex* is a coastal Queensland species (Cogger, 2000) whose habitats and continued survival are threatened by clearing of vegetation. Thus it seems timely to report the results of recent observations in the wild (particularly in the Rockhampton district) and captive breeding at Australia Zoo, Beerwah, Queensland. This study was undertaken under permits issued by the Queensland Parks and Wildlife Service.

DESCRIPTION

Nostrils are closer to the tip of the snout than to the eye. Head colouration is predominantely brown with yellow scale edges and may have a temporal mauve tinge extending along the upper neck. The lower lips have faint brown bars. Under the chin and along the throat is yellow-orange. The body is grey with irregular black flecks and the ventral surface is pale yellow, with irregular, thin, brown banding. The tail is grey-black and lacks discernable pattern; it is round in section at the base and laterally compressed distally. Total length for adults is approximately 650 mm. The tail is between 1.3 and 1.7 times longer than the head and body. Scales around the midbody number 85-105 (Cogger, 2000).

Specimens from the west of Cape York Peninsula are darker brown with light coloured ocelli on the back (Wilson & Knowles, 1988). The Queensland Museum has four specimens from the east of Cape York Peninsula, all resembling specimens from the south and lacking the dark colour with distinct light ocelli (pers. obs.).

TAXONOMY

Varanus (Odatria) semiremex has had a long, stable taxonomic history. It was described by Wilhelm Peters in 1869. The species name means 'half rower'. Cogger *et al.* (1983) list only two names in the synonymy of *V. (O.) semiremex*: *Odatria semireme* Günther 1875 and *Varanus boulengeri* Kinghorn 1924.

DISTRIBUTION AND HABITAT

V. semiremex occurs near the coast in Queensland's tropics and subtropics (Ingram & Raven, 1991). It has been recorded from both western and eastern Cape York Peninsula and, in a number of isolated populations, including small offshore islands, south to the Gladstone area, southeast Queensland. Only one exception has been recorded, a specimen collected in November 1939, reportedly from near the Ord River, WA (Mertens, 1961). Few specimens are held in Australian museum collections; in April 2002 the Queensland Museum had 14 specimens and the Australian Museum 19.

The Rusty Monitor favours coastal and estuarine mangrove communities (Wilson & Knowles, 1988), foreshores of small islands (Cogger, 2000) and melaleuca swamps (Ehmann, 1992). In the south of its range, *V. semiremex* appears to be restricted to coastal mangroves, with its habitat being dominated by the Spotted Mangrove *Rhizophora stylosa*

Figure 1. Rusty Monitor (*Varanus semiremex*) from Rockhampton district, Queensland

and the Grey Mangrove *Avicennia marina* (pers. obs.). The monitors are particularly dependent on the Grey Mangrove, utilizing hollow limbs of mature trees and sheltering in dead, completely hollow trees. Dead Grey Mangrove trees may be a 100 years old at death, but continue to stand for a long time afterwards. They are also incredibly fragile and easily damaged. Peters (1969) recorded one specimen in a mangrove tree *Rhizophora micronanta* and noted the habitat included such other plants as *A. marina, Bruguiera gymnorrhiza* and *Sonneratia alba*. In the north, *V. semiremex* has been found in fresh-water melaleuca swamps (Cameron & Cogger, 1992; S. Wilson, pers. comm.) and, in some areas, adjacent habitat to the mangroves also appears to be utilised by *V. semiremex* (pers. obs.).

NATURAL HISTORY

Tree Preference

The continual use of some mangrove trees by *V. semiremex* has given rise to what is often referred to as a 'home tree'. These home trees are determined by shed monitor skin in the hollows and crab remains scattered at the

tree's base or crevices and hollows (Peters, 1969; pers. obs.). In the field, it has often been that certain Grey Mangrove trees seem to yield a better chance of finding a monitor present (pers. obs.); whether these are actual home trees or this is due to lack of availability in preferable hollows is undetermined. Further investigation is required to establish exactly what ties *V. semiremex* may or may not have to a home tree.

Seasonal and Daily Activity

During winter the most southerly populations of *V. semiremex* tend to move around in their hollows, following the sun to thermoregulate, and are rarely active apart from this (pers. obs.). They are reported to be seasonally active in the north between February and June (Cameron & Cogger, 1992).

Daily activity is affected by the tide. Thus, lizards are active when the tide is out and often leave visible tracks on the mangrove mud (Dunson,1974; pers. obs). Foreshore sand behind the mangroves in some areas also often shows tracks revealing some of the day's activity and foraging.

Feeding

The known wild diet consists of crustaceans, fish and frogs (Dunson, 1974; James *et al.*, 1992). One sample collected by Australia Zoo from the field was examined at the Queensland Museum and found to contain fragments of arthropods: mostly parts of a Katydid (Orthoptera: Tettigoniidae), leg parts of a spider and some crab fragments of a mangrove species, probably Grapsidae, sub-family Sesarminae. Popular literature lists crustaceans, fish, frogs, insects, lizards and small mammals (Swanson, 1976; Ehmann, 1992; Vincent & Wilson, 1999; Cogger, 2000). With most of this prey occurring in a brackish environment, the Rusty Monitor excretes excess salt through well-developed nasal salt excretion glands (Dunson, 1974; Ehmann, 1992; Vincent & Wilson, 1999).

THREATS TO SURVIVAL

Habitat Destruction

Since European settlement the estimated change in *V. semiremex* range is between 1-24% (Cogger *et al.*, 1993), with loss of mangrove forests likely to be the threat of most concern to *V. semiremex*. Further, adjacent habitats to the mangroves, such as woodland or *Melaleuca* swamps, are also often cleared for roads, agriculture, urban and industrial developments. Such activities render the mangrove habitat isolated and Australia Zoo staff have been unsuccessful in finding *V. semiremex* in such areas.

In the past there was destructive collecting for the keeping 'trade', with *V. semiremex* being heavily collected from the wild in the Rockhampton district during the 1970s (S. Irwin, pers. comm.). The destructive manner in which this was done, using chainsaws to open hollow trees, left some populations to struggle in seriously altered habitat (pers. obs.). There have been no reports of such destructive collecting occurring since the 1970s.

Cane Toad

Rusty Monitors have been found dead after having attempted to consume the Cane Toad *Bufo marinus* (S. Irwin, pers. comm.). Cane Toads have been found sheltering in hollows on the ground and close to the ground in areas where the Rusty Monitors forage (pers. obs.). However the full extent of Cane Toad impact on *V. semiremex* may be difficult to quantify. I have found *V. semiremex* to be easily located at two localities in the south of their range, despite the presence of the Cane Toad.

CAPTIVE MAINTENANCE

Housing and Husbandry

The founding four wild-caught Rusty Monitors were initially held in small individual enclosures at Australia Zoo. Enclosure size for each animal was 730 mm L x 530 mm W x 450 mm H, with newspaper for substrate, a small hollow log for shelter, large water bowl to allow soaking and fig tree branches so that the lizards could feel secure. All specimens had access to natural sunlight and a 40 watt Blue light globe provided heat. All lizards settled in well and quickly became accustomed to cleaning procedures. They all also accepted food from forceps whilst in the security of their hollow within the first few days.

On 20 September 1999 the lizards were moved into enclosures designed for breeding arboreal lizards. The dimensions were 1.8 m L x 1.8 m W x 2.1 m H (at its highest point). Keeper access was via a standard size house door measuring 175 cm H x 72 cm W. The door incorporated a small viewing window 30 cm H x 18 cm W to allow viewing of the lizards with minimal disturbance. The walls were rendered concrete. The roof had a skylight, which was opened on sunny and overcast days to allow direct sunlight into the enclosure. Due to Queensland's weather conditions, the skylights were able to stay open most of the year round, but were always closed at night regardless of weather conditions. Stainless steel woven wire mesh stopped the lizards from escaping through the skylight and the lizards sometimes hung from this, sunning their bellies. No problems were encountered with nose rub using this mesh.

Figure 2. Enclosure for Rusty Monitors at Australia Zoo.

The rendered walls and a drain in the floor allowed hosing of the enclosure after cleaning. A 'substrate' of large gravel rocks aided drainage to avoid/reduce bacterial build-up. This was time efficient and extremely hygienic.

Two large horizontal branches approximately 60 cm apart extended across the enclosure at heights of 1.4 m and 1.7 m above the floor. They provided horizontal basking sites, with the higher branch situated 40 cm below a heat pad measuring 180 cm L x 38 cm W. Other branches extended to the floor, allowing lizards access to a large water bowl 40 cm in diameter x 6 cm deep. Also running between the two horizontal branches were flat pieces of bark, approximately 60 cm long and 25 cm wide. These were placed at an angle of 45° to the skylight. On sunny days when the skylight was open, the bark was a favorite basking site. On hot days, when the bark reached a temperature up to 56°C, the lizards would still bask on them. On cool days, when the skylights were closed, each enclosure had one or two 80 watt spotlights switched on. These were directed at the bark and created a basking site of 32°C, providing an alternative to the heat pad. On cool, overcast days the lizards could still benefit from available UV light as the skylights could be opened and combined with the heat from the pad or spotlights. Ambient air temperature in each enclosure was maintained at 24-33°C.

Enclosures were decorated with 3-4 fig trees in large pots. This helped to create a naturalistic environment, increasing security for the lizards, providing dappled direct sunlight and creating a thermal gradient at the highest points of the enclosures. Both enclosures had five small hollow logs attached to branches, all at least 90 cm above the enclosure floor. The hollows were positioned horizontally, vertically and at angles. There was no preference in choosing the angle of the hollow, but individual specimens did favour particular hollows.

The diet was mainly crickets and cockroaches. Insects were offered twice a week, dusted with vitamin and calcium supplement powders. Chopped or small whitebait and prawns were also provided to replicate the fish and crustaceans in the lizard's wild diet. Pre-killed pink mice or rats were fed once a week at most. Food items were always offered individually from forceps daily or every second to third day.

Introductions and Mating

Two pairs were introduced into separate new enclosures on 20 September 1999. When first removed from a bag after capture, one lizard L268 everted a hemipenis. We paired this specimen with an assumed female L269 as a priority. Another two lizards L270 and L271 were introduced to a second enclosure. Sexing *V. semiremex* can be difficult, but subtle head differences suggested that the lizards housed together were opposite sexes. Both pairs coexisted well, sharing hollows and

emerging to bask, side by side. No aggression was observed.

After nearly four months, during the wet season month of February 2000, the first mating behavior was observed. Our lizards often shared the same hollows and this often made it difficult to observe interactions between them. We suspected that copulation was taking place in the hollows, as the two pairs shared hollows more often than previously. We limited disturbance, so could not confirm copulation till 25 February 2000, when lizards L269 and L268 were observed copulating in a hollow. Throughout this breeding season both pairs constantly shared the same hollow and we believe copulation was frequent. First suspected copulation for pair L270 and L271 was on 10 February 2000. Throughout March both females increased the time spent basking on the bark, flattened with their backs exposed to the direct sun. They became distended in the abdomen, particularly just in front of the hind legs, thus displaying positive signs of having become gravid. Courtship resumed after each female had laid their first clutch (refer to "Egg Laying").

On 21 April 2000, pair L269 and L268 were again copulating in a hollow. The other pair, L270 and L271, were found copulating again on 28 April 2000 at 0750 hrs, also in a hollow. Later that day, at 1448 hrs, they were observed copulating in the open on the bark, the first time either pair had been observed copulating outside a hollow. They were easily disturbed and retreated to a hollow. They resumed copulation in a hollow at 1515 hrs. Following this resumption of matings, both females again became gravid and laid their second clutches for the season (refer to "Egg Laying").

On 10 November 2000 we added a second female (L124) to the enclosure of pair L268 and L269. All three lived without aggression until midway through the breeding season in 2001. Females L124 and L269 had laid their first clutches of eggs in the same nest box ten days apart. The females were investigating the nest box prior to laying their second clutch

when the aggression occurred, presumably over a nest site. The slightly larger, apparently more dominant female (L124), inflicted superficial lesions to female L269 on the forelimbs and snout. Subsequently, L269 was removed and allowed to recover separately. In 2001, the first confirmed mating was between L270 and L271 on 30 January. They were observed copulating at 1645 hrs in the open on the exposed bark. Copulation in the open became common in the second season, suggesting the lizards had become more accustomed to captivity.

Egg Laying

Nest boxes were constructed of plywood 680 mm L x 125 mm W x 245 mm H. A nest box was placed on the floor of each enclosure and 2/3 filled with moist potting mix covered by a layer of sphagnum moss. Water was added until the mixture was slightly moist to touch and maintained at that level by adding extra water as required. Heat tape on one side of the nest box kept the mixture at 26-30°C. Females repeatedly investigated and spent time in the nest boxes for about two weeks prior to depositing eggs. They continued to feed throughout this time and ate small amounts of food even a day prior to laying. However, if food was offered generously in the last week prior to egg deposition a decrease in appetite was apparent in the last few days. All clutches of eggs produced were laid either in the early morning, during the day or late evening.

The first clutch contained 10 eggs and was laid by L269 on 30 March 2000. On 14 April 2000 the second female (L270) laid 12 eggs. The two females fed well after depositing their eggs and retained good condition. The weather remained warm and we felt it possible that the lizards may 'double clutch'. Food was generously supplied and on overcast days the ambient temperature was maintained at around 26°C with the basking sites at 32°C. On 2 June 2000, L269 laid 11 eggs and L270 laid 8 eggs.

Matings in 2001 resulted in female L270

'triple clutching', female L124 produced two clutches and female L269, after having laid one clutch, was housed separately. Over the two years of breeding 125 eggs were laid. Clutch data are summarized in Table 1.

Incubation

Eggs were removed, measured and weighed once the female had finished back-filling the soil and left the nest box. Incubation techniques were varied initially, using ratios of 1:1, 1:2 and 1:3 water/vermiculite. Greatest success was achieved with a 2.5 litre plastic container 2/3 filled with a ratio of 1:1 vermiculite to water, with approximately 12 eggs per container, incubated at 30°C. The container lid was removed briefly once a week to allow for air exchange.

Hatchlings

The first of the captive-bred *V. semiremex* hatched on 6 November 2000, after an incubation period of 242 days. Seventeen eggs successfully hatched the first year and 45 hatchlings the year after. The majority of eggs had an incubation period between 200 and 220 days.

The hatchlings were more vibrantly coloured than adults. They had a bright orange head, with a reticulated pattern on the sides; yellow flecks on the forelimbs, bright yellow under the chin and belly; while the body was dark brown with irregular white spots, some of

Table 1. Eggs laid by *V. semiremex* in 2000 and 2001. Mass, length and width are expressed as range (mean).

Date of Lay	Clutch Size	Mass (g)	Length (mm)	Width (mm)
Female L269				
(a) 30 March 2000	10	4-6 (5.3)	30-31.5 (31.2)	17-19 (17.8)
(b) 2 June 2000	11	5-7 (6.2)	29-34 (31.9)	17-19 (18.1)
(c) 23 March 2001	14	4-6 (4.9)	27-30 (28.0)	16-17 (16.6)
Female L270				
(d) 14 April 2000	12*	5-8 (6.8)	31.5-37 (34.2)	17.5-19.5 (18.5)
(e) 2 June 2000	8	7 (7.0)	33.5-35.5 (34.3)	18.5-20 (19.3)
(f) 26 Feb 2001	11**	-	-	-
(g) 6 April 2001	13	5-7 (6.5)	30-35 (31.9)	15-17 (16.6)
(h) 24 May 2001	10***	5-7 (6.4)	36-38 (36.4)	16-18 (17.6)
Female L124				
(i) 2 April 2001	21	6-8 (7.2)	28-33 (30.5)	17-18 (17.7)
(j) 12 May 2001	15****	6-7 (6.3)	29-33 (30.4)	16-17 (16.6)

*All eggs from this clutch appeared viable when laid; later all found to be infertile
**2 eggs discarded; 9 eggs desiccated in nest box
***2 eggs laid 23 May discarded, omitted from measurements
**** 1 egg discarded, omitted from measurements

which became ocellated within the first couple of weeks. The partly ocellated pattern of some hatchlings faded after 2-6 months of growth into the grey back, black-flecked pattern commonly seen in adults.

Housing, maintenance & behaviour of hatchlings through to sexual maturity

Hatchlings were initially kept in the incubator in a plastic container lined with moist paper towel. After 3-7 days they were moved to 450 litre plastic tubs, which were 120 cm L x 60 cm W floor space and had a depth of 60 cm. Each tub had a 80 watt spotlight creating a basking site of 38°C and was held in a room where the ambient temperature never dropped below 22°C. On sunny days the tubs were wheeled to half in the sun to allow access to direct sunlight for UV and created a basking site of 42°C. Newspaper was used as a substrate and was changed daily. A fresh cut fig branch with foliage was added for security and climbing, and was replaced every two days.

Diet of the hatchlings was primarily crickets, occasionally dusted with vitamin and calcium supplement powders. As the hatchlings grew, they were gradually transferred to the adult diet previously mentioned. The lizards were fed every 1-2 days.

Housing large groups of hatchlings rarely presented a problem, with up to 20 hatchlings per 450 litre tub for the first two months. To reduce competition, the daily amount of food offered was generous. A few individuals were aggressive towards others, involving chasing, biting and sitting on the subordinate. Removal of the aggressive individual resulted in a return of harmony for the remaining

Table 2. Weights and lengths of neonate V. *semiremex* hatched at Australia Zoo in 2000 and 2001.

Clutch labels refer to entries in Table 1.
Range of dates given are from the first to the last hatched lizard for a clutch.

Clutch	No. of hatchlings	Date(s)	Mass (g)	SVL (mm)	Total length (mm)
(a)	1	6 Nov 2000	4	66	166
(b)	8	24 Nov - 9 Dec 2000	3-5 (4.2)	57-72 (68.3)	156-192 (172.7)
(c)	8*	31 Sept - 14 Oct 2001	3-5 (4.1)	60-81 (72.3)	143-197 (177.0)
(e)	8	8-22 Jan 2001	3-5 (4.1)	62-79 (74.6)	161-199 (184.5)
(g)	7	29 Oct - 12 Nov 2001	4-6 (5.0)	70-81 (76.0)	175-208 (189.6)
(h)	4	20-24 Dec 2001	4-5 (4.5)	64-79 (74.8)	154-202 (181.8)
(i)	15	10 Oct - 8 Nov 2001	3-6 (5.1)	71-80 (76.1)	169-203 (190.8)
(j)	11	8-20 Dec 2001	4-5 (4.3)	71-77 (75.4)	176-192 (184.2)

*Includes twin neonates from one egg

Figure 3. Hatchling Rusty Monitor emerging from egg

group housed together. As the lizards grew they were further divided into smaller groups to maintain husbandry standards and prevent further aggression.

Before these *V. semiremex* reached a subadult size, two notable behaviour traits were observed. One was pseudocopulation, where no penetration occurred and the lizards were too small to reproduce. The lizard making the advances was usually a male. The second behavior was tail-waving, observed on several occasions.

The first definite copulation of the captive-raised *V. semiremex* occurred on 3 March 2002. The lizards were 15 months of age, with the male having a snout vent length of 187 mm and the female 204 mm. No ritualized combat was ever observed. Once the *V. semiremex* had become sexually mature, sexing was made easier by observing male - male aggression and male advances towards females. Females generally kept to themselves.

Growth rates

A total of 17 lizards, from clutches (a), (b) and (e) were weighed and measured from hatching through to sexually maturity. The two lizards chosen for Figure 4 are representative of the growth patterns of all lizards. No outstanding variation in growth between the three clutches occurred.

DISCUSSION

Based on the examination of museum specimens, the Rusty Monitor is a wet season breeder (James *et al.*, 1992). The Australia Zoo, Beerwah wet season (January – April) coincides with that of the collection site in the Rockhampton area. The monitors in this study were constantly exposed to natural stimuli, such as seasonal temperature and photoperiod, through the inclusion of the skylights in their enclosures, and hence the timing of mating in the captive colony is presumed to be similar to that in the wild. Lizards in the captive colony mated in the wet season. The first generation captive-bred monitors were

Figure 4. Growth rates for two captive-raised *V. semiremex* at Australia Zoo. Measurements are of snout-vent length (in mm).
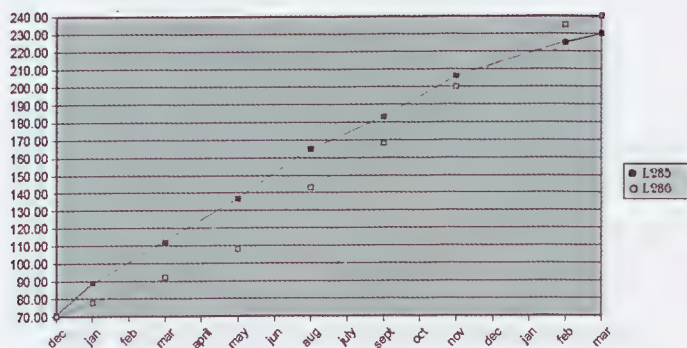
also exposed to natural stimuli and their breeding behaviour also took place in the wet season.

The enclosures used for the breeding of the *V. semiremex* were of the same design that had been previously used at Australia Zoo to breed the Canopy Goanna *V. keithhornei* (Irwin, 1996).

The size and weights of eggs from clutches laid at Australia Zoo are in agreement with those previously published for *V. semiremex* (De Lisle, 1996). The gestation period was determined to be around four weeks, based on the time span between consecutive clutches laid by individual females. Clutch size for *V. semiremex* was previously recorded as up to 14 eggs (Horn in James *et al.*, 1992); one clutch of 21 eggs at Australia Zoo increased the known clutch size by seven eggs. Further, at the subgenus level of *Odatria*, the only species known to have produced a larger clutch is Mitchells Water Monitor *V. mitchelli* with a clutch of 23 eggs (G. Gaikhorst, pers. comm.).

It was presumed that lizards too young to mate, but found in a copulatory position on another lizard, were adolescent males. However, female Ridge-tailed Monitors V. acanthurus have been observed to pseudo-copulate with other females, which is thought to be an assertion of dominance (J. Lemm,

per. comm.). The captive-bred *V. semiremex* were observed tail-waving on several occasions. This behavior has been reported in captive *V. storri* and *V. gilleni*, and in wild *V. gilleni* (pers. obs.), and is thought to be a threat response to human observers (Vincent & Wilson, 1999).

The estimated snout-vent length for both sexes at sexual maturity has been reported as 150 mm (James *et al.*, 1992). The first captive-raised *V. semiremex* observed copulating measured 187 mm SVL for the male and 204 mm for the female. Once maturity is reached some individuals became more obviously territorial, with dominant males biting sub-ordinate males by the ribs and hanging on. This aggression has the potential for serious injury. Hence any display of aggression resulted in one of the lizards involved being moved to a separate enclosure.

A number of *Odatria* monitor species have spur-clusters near the vent, e.g. Black-Tailed Monitor *V. tristis* (Bennett, 1995; Vincent & Wilson, 1999). These can be used to determine sex as males have larger clusters. *Varanus semiremex* lack any enlarged scales near the vent and therefore cannot be sexed using this method. It is not known whether hemipenial bones are visible on radiographs and ultrasound was not tried as a sexing method.

The lizards used in this study were collected under a permit issued by Queensland Parks and Wildlife Service to Australia Zoo in order to gain further knowledge of the reproductive biology of Rusty Monitors through captive breeding. Once this objective had been achieved, following all relevant health checks, the founding animals and their offspring were released back to the wild at the collection site, as per permit requirements.

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OBSERVATIONS OF CALLING AND BREEDING OF FROGS IN CENTRAL WESTERN NEW SOUTH WALES

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INTRODUCTION

Many Australian frogs in seasonally arid areas are fossorial, emerging only after significant rainfall events, to engage in brief reproductive and feeding events (Morton *et al.*, 1993; Predavec & Dickman, 1993; Tyler, 1994). Perhaps due to the infrequent and unpredictable nature of rainfall in these areas, there is a paucity of information relating to frogs in such zones (Read, 1999a; Tyler, 1994). In addition, due to their sporadic periods of activity, burrowing frogs are often poorly represented in museum collections and undetected in fauna surveys of a region (Predavec & Dickman, 1993).

While a number of frog surveys conducted in relatively dry regions (<500 mm rainfall per annum) have detected burrowing species, the information recorded is largely presence/absence data, with only a small number of studies quantitatively recording abundance (e.g. Morton *et al.*, 1993; Predavec & Dickman, 1993; Read, 1999b). In addition, abundance information for burrowing frogs tends to be from pitfall trapping and road counts and there is little information on frog diversity or abundance at breeding aggregations, or on the calling site choice of frog species at ephemeral pools.

During February 2003, heavy rains occurred over much of central west New South Wales, providing the ideal conditions in which to conduct a survey of the frogs occurring in the region. The species diversity, abundance and calling sites of frogs found at temporary pools in the Parkes and Lachlan Shires were investigated.

METHODS

Amphibians were surveyed in the Parkes and Lachlan Shires, central west New South Wales. Rainfall in the region is sporadic and aseasonal, with an average of approximately 450 mm per annum. Land-use in the region consists primarily of grazing, cropping and forestry (MDBC, 2004), with the area being extensively cleared or otherwise modified (Schrader, 1987). State forests throughout the region preserve remnants of original vegetation, which is typically dry sclerophyll woodland (Schrader, 1987).

Following the largest rainfall event in the area for approximately 12 months (over 60 mm of rain in a few days; Australian Bureau of Meteorology), there was an abundance of ephemeral pools. These pools formed the basis of the survey, as they are the focus for intense breeding activity by a number of frog species.

Five sites were surveyed over three nights (Table 1). An individual site was defined as an area of frog calling activity, and typically included several water bodies in close proximity. Site 3 was targeted due to historical records of *Notaden bennettii* in the proximity, and site 4 was chosen from a topographic map that indicated waterbodies present in the area. All other sites were detected by driving along roads in the area at night, listening for calling activity.

At each site, the number of species present, and abundance of each species was recorded. Where the number of individuals of a species present at a site was too high to accurately determine exact abundance, abundance was categorized as follows: 10-25, 25-50, 50-100 or >100 individuals. In addi-

Table 1. Detailed account of survey sites.

Site	Location	Date Surveyed	Time surveyed	Site description
Site 1	approx. 4 km N of Parkes (33°06'18.6"S 148°10'07.4"E)	21.02.03	2230-2415 hrs	Shallow ponds in a cattle paddock, littered with garbage.
Site 2	approx. 9 km S of Condobolin (33°09'56.4"S 147°07'05.3"E)	22.02.03	2100-2130 hrs	Flooded roadside verge
Site 3	approx. 20 km S of Condobolin (33°16'54.7"S 147°05'38.4"E)	22.02.03	2230-2430 hrs	Expansive, shallow flooded area in cattle paddock. Spans several hundred meters
Site 4	Weelah State Forest, approx. 30 km S of Condobolin (33°20'52.6"S 147°12'50.4"E)	23.02.03	1600-2250 hrs	Flooded roadside verges, large ponds
Site 5	approx. 25 km S of Condobolin (33°17'51.3"S 147°05'34.5"E)	23.02.03	2300-2450 hrs	Flooded roadside verge.

tion, the site of calling males was recorded.

RESULTS

Eleven species were observed over three nights, with a maximum of seven frog species and a mean of 5.2 species at a single site (Table 2). Overall, the most abundant species was *Neobatrachus sudelli*, followed by *Notaden bennettii* and *Uperoleia rugosa*. *Neobatrachus sudelli* was also the most widespread species, occurring at all five sites. In contrast, *Crinia sloanei* was detected only once (Table 2).

Calling males of each species were found in specific sites. While males of most burrowing species called from the water body (see

Fig. 1), non-fossorial species were most often found calling from elevated positions such as trees or on top of rock piles (Table 3).

DISCUSSION

Eleven species of frogs recorded from only five sites is relatively high for Australia. For example, during surveys in southern New South Wales, in an area of similar rainfall to the present study, only six species of frog were found at 26 sites along a 600 km stretch of floodplain (Jansen & Healey, 2003). Species richness in the present study is also high when compared to more arid regions, with only four species of frog recorded at eight sites in the Tanami Desert, Northern Territory (Morton et al., 1993), and three species along an 11

Table 2. Total number of individuals of each species at each site, and whether the species was heard calling or observed in amplexus.

Site	Species	No. Males	Calling?	Amplexus?
Site 1	Litoria caerulea	16	P	P
	Neobatrachus sudelli	10	P	P
Site 2	Litoria caerulea	3	P	
	Litoria latopalmata	10-25	P	
	Litoria peronii	25-50	P	
	Litoria rubella	3	P	
	Limnodynastes tasmaniensis	3		
	Uperoleia rugosa	25-50	P	P
Site 3	Cyclorana platycephala	10-25	P	P
	Litoria caerulea	3	P	
	Litoria rubella	1		
	Crinia sloanei	1·	P	
	Limnodynastes tasmaniensis	10-25		
	Neobatrachus sudelli	>100	P	P
	Notaden bennettii	>100	P	P
Site 4	Litoria caerulea	2		P
	Litoria rubella	2		P
	Limnodynastes interioris	10-25	P	
	Neobatrachus sudelli	10-25	P	
	Notaden bennettii	1	P	
	Uperoleia rugosa	10-25	P	
Site 5	Cyclorana platycephala	1	P	
	Litoria rubella	3	P	
	Neobatrachus sudelli	>100	P	
	Notaden bennettii	10-25	P	
	Uperoleia rugosa	50-100	P	

km transect in southwest Queensland (Predavec & Dickman, 1993). In contrast, a number of surveys have detected higher numbers of species than found in the present study (e.g., Hazell et al., 2004; Lemckert, 1999), but direct comparisons are difficult due to differences in spatial scale and the number of sites surveyed. The only roughly comparable study was that by Palmer and Pidcock (2001), where, after a significant rainfall event, 15 species were found over two survey nights in the Mitchell grasslands of southwestern Queensland.

Perhaps of more interest is the high species richness at single sites. Site 3, with seven species, is especially high. To illustrate how

high this figure is, during a survey of 913 sites located throughout South Australia, no sites contained greater than six species (Walker & Goonan, 2000). Further, only 0.2% of sites contained six species, and 1.1% contained five species (Walker & Goonan, 2000). Similarly, a maximum of six species was found at 60 sites in an area of similar rainfall in southern New South Wales, and the average species richness at these sites was only 1.3 (Parris & Lindenmayer, 2004). Species richness at individual sites in the present study was also relatively high when compared to areas of higher rainfall. For example, a maximum of eight species at a single site was detected during surveys of 44 sites in southern tablelands of New South

Table 3. Calling sites of each species observed during the study.

Species	Calling site
Cyclorana platycephala	Floating in open water, sometimes amongst emergent vegetation
Litoria caerulea	On elevated banks, in trees.
Litoria latopalmata	On banks/ground near waters edge.
Litoria peronii	On bank, in trees.
Litoria rubella	On ground near waters edge.
Crinia sloanei	In water, under emergent vegetation.
Limnodynastes interioris	Floating in water, facing bank. Typically under overhangs/tree roots.
Limnodynastes tasmaniensis	In water, within emergent vegetation.
Neobatrachus sudelli	On banks, or floating in water, often within emergent vegetation
Notaden bennettii	Floating in water, especially at base of emergent vegetation (Fig. 1).
Uperoleia rugosa	On bank, often amongst vegetation.

Wales (Hazell et al., 2004), and a maximum of seven species from 65 sites in subtropical north-east New South Wales and south-east Queensland (Parris, 2004).

Along with high species richness at each site, individual frog species were also often abundant, with over 100 individuals each of Neobatrachus sudelli and Notaden bennettii at site 3. However, such abundance is not surprising as previous studies have reported extremely high densities (34-200 frogs per ha) of burrowing frogs via pit-trapping (Morton et al., 1993; Read, 1999b). As frogs aggregate at ephemeral water bodies to breed, the abundance of frogs in such areas is likely to be much higher than reported from pit-trapping.

Despite surveying at an ideal time (after heavy rainfall), it is possible that we underestimated the number and abundance of frog species present in the area. If the surveys had been conducted over a longer period, and encompassed a higher number of sites, we may have detected several more species. In particular, Crinia parinsignifera, C. signifera,

Limnodynastes fletcheri and L. dumerilii have been recorded in the general area (Bell, 1987) but were not detected during our survey.

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Figure 1. Male *Notaden bennettii* calling from among emergent vegetation, while floating in the water.

INTRASPECIFIC COMBAT IN FREE RANGING SCRUB PYTHONS *MORELIA KINGHORNI* (SERPENTES: PYTHONIDAE) IN NORTH-EAST QUEENSLAND

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INTRODUCTION

Male combat appears to be widespread among Australian Pythonidae. However, this behaviour has been largely documented from captive specimens (Greer, 1997; Torr, 2000). The only documented combat bouts for free ranging pythons both involve members of the genus *Morelia*. Male carpet pythons *M. spilota* (*M. s. mcdowelli* of some authors) from northern coastal NSW and coastal Queensland commonly engage in vigorous combat bouts (Shine & Fitzgerald, 1995; Fearn et al., 2001). Male scrub pythons *M. kinghorni* (*M. amethistina* in earlier literature) are well known to combat under captive conditions (Ross & Marzec, 1990; Barker & Barker, 1994), but only one description of this behavior has been published for free ranging specimens (Sues & Shine, 1999). In snakes generally, such agonistic combat bouts appear to exert selective pressure for larger male body size, relative to conspecific females, through increased mating success for the victors of combat bouts (Shine, 1978, 1994), a characteristic strongly demonstrated in *M. kinghorni* (Fearn et al., 2005).

In this work, we present a record of male combat for *M. kinghorni* that differs in several respects to previous descriptions (Sues & Shine, 1999), as well as presenting the first published photographs of this behaviour.

OBSERVATIONS

One of us (RL) made the following observations on 29 June 2004 at 1230 hr at Little Crystal Creek on the Paluma Road, Paluma Range, north Queensland (19°00'55"S 146°15'55"E). It was a sunny day with 10% cloud cover and an ambient temperature of 22°C. The observer's attention was drawn to two large adult *M. kinghorni* (approximately 3.6 m total length) engaged in a vigorous combat bout among long grass at the top of a steep embankment on the margin of Little Crystal Creek. The snakes were entwined around each other while progressing forward with heads and fore bodies raised above the substrate. This vigorous wrestling eventually resulted in both snakes tumbling down the embankment onto the verge of the sealed road below. This allowed close observation and photographic opportunities for 25 minutes. After several moments of lying together in a heap, the snakes continued as before, progressing forward with bodies entwined and heads raised (Fig. 1). The snakes were constantly raising their heads and fore bodies as high as 1 m from the substrate while simultaneously attempting to press down the head of the opponent, either from directly above or from the side (Fig. 2). During the course of these sometimes violent movements, one of the snakes regularly greatly expanded its throat with air (Fig. 3). This 'air pocket' was not expelled as a hissing sound but appeared instead to be some sort of visual signal to the other snake. No attempts to bite each other were observed and no wounds of any type were present on either snake. The observations ceased when the snakes moved onto the road and were in considerable danger of being struck by increasing volumes of traffic. The snakes were gently picked up at mid-body while still engaged in combat and removed back to the road verge where they disengaged and retreated in opposite directions into thick vegetation. Both snakes appeared to be very similar in length and mass (Fig. 1).

DISCUSSION

The combat bout described here is very similar to those reported and photographed for M. *spilota* (see photographs in Greer, 1997 and Kend, 1997) and a previous description of combat in M. *kinghorni* (Sues & Shine, 1999). The combat bout described by us differs from that of Sues and Shine (1999) in two respects. Firstly, the animals involved made no attempt to bite each other and secondly, the curious 'throat swelling' behaviour of one of our snakes. Male M. *kinghorni* appear to commonly savagely bite each other during combat bouts. During dry season aggregations of scrub pythons in rocky gorges in north Queensland (which coincides with the reproductive season from June to September), large males are commonly encountered with extensive dorsal combat bite wounds which take the form of clean cut, straight edged parallel striations that can be deep enough to expose underlying musculature, tendons and ribs (Fig. 4) (Fearn et al., 2005). In addition, combat bouts can be of such duration and intensity that dorsal scales over the whole body of both combatants can be scuffed and abraded to the point where no natural iridescence (a distinctive characteristic of this taxon) is left on them (S. Fearn, unpublished data). The lack of biting in this report, coupled with the pristine condition of the dorsal scales of both snakes, indicate such combat bouts may vary in intensity, depending perhaps, on how evenly matched in body size the combatants are. Alternatively, the combat bout reported here may have been terminated by the necessity of handling the animals before the contest reached the biting stage.

It appears from the literature that a consistent aspect of such combat bouts in *Morelia* is that the snakes involved are large, mature specimens that are very evenly matched in terms of length and mass (Sues & Shine, 1999; Fearn et al., 2001, 2005). These data indicate that smaller, subordinate males would not be inclined to engage in combat with larger, more dominant conspecifics. This may

Figure 1. Combating male scrub pythons with bodies entwined and heads raised.

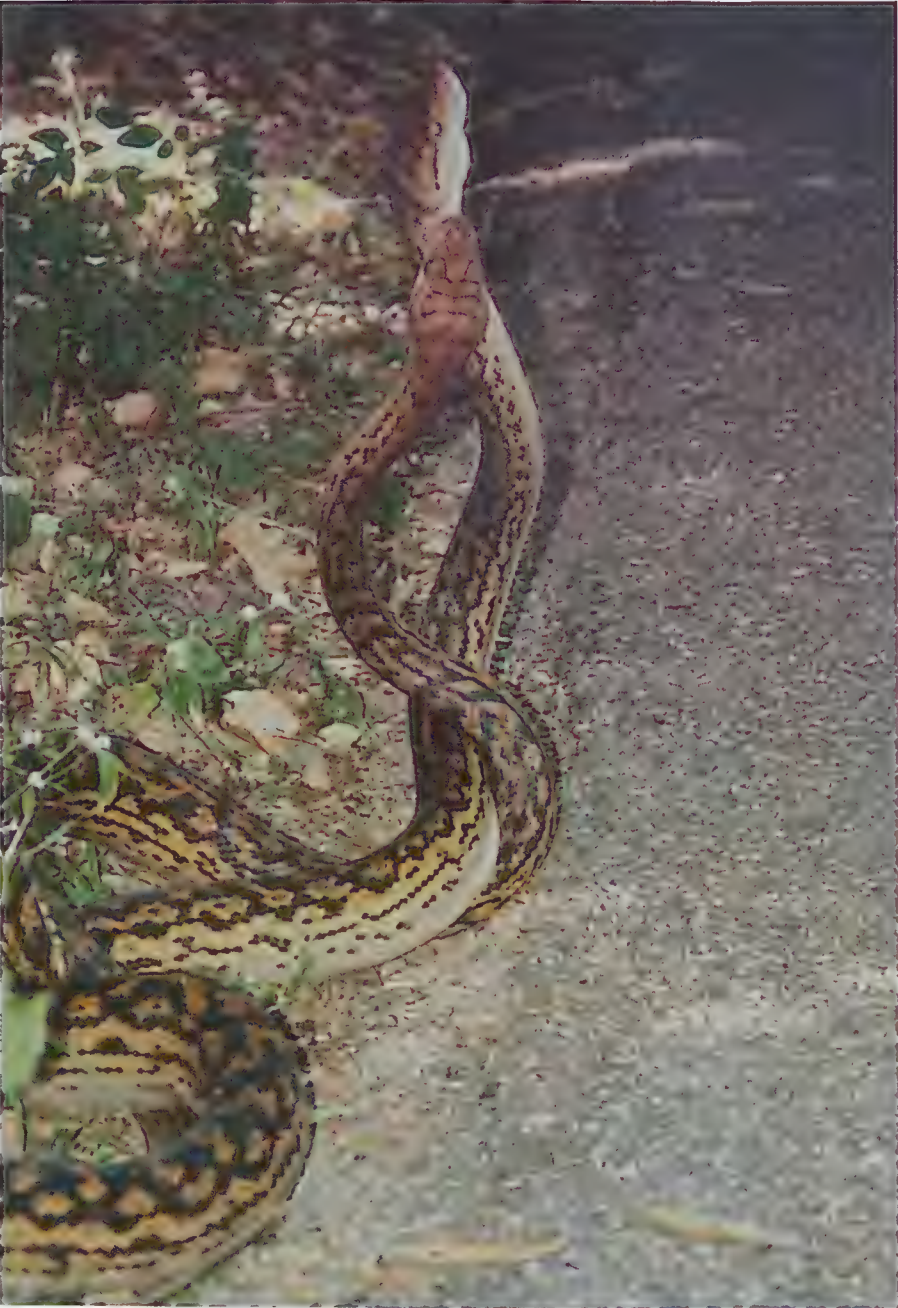**Figure 2. Combating male scrub pythons with heads and forebodies raised above substrate.**

Figure 4. Male-male combat wounds on *Morelia kinghorni*. Tully Gorge, north-east Queensland. August 2001.

explain the suggestion by Sues and Shine (1999) that male-male tolerance occurs in dry season aggregations of *M. kinghorni* in north Queensland. Extensive field work in the Tully Gorge indicates that large males of similar size are highly intolerant of each other and when placed together, immediately adopt aggressive combat postures with heads raised, explosive hissing and violent lateral thrashing of their bodies (S. Fearn, unpublished data).

Previous literature records indicate that male-male combat in *Morelia* is initiated by proximity to sexually reproductive females (Shine & Fitzgerald, 1995; Sues & Shine, 1999). However, no search was made on the grassy embankment where the combat in this work was first observed so it could not be determined if a female was close by.

Our observations that one of the snakes repeatedly filled its throat with air deserves further study. Hammond (1988) observed similar behaviour in two combating captive *M. spilota* and attributed the behaviour to respiratory distress caused by the vigour and duration of the combat bout. The snake we observed did not appear to be in respiratory distress and was not breathing heavily.

Given the widespread ownership of video and digital recording equipment, coupled with the fact that *M. kinghorni* is common throughout the wet tropics of north Queensland, we urge field biologists and members of the public to film agonistic interactions between these snakes and make such recordings available to professional herpetologists for detailed analysis.

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PREDATION OF A STRIPED MARSH FROG (*LIMNODYNASTES PERONII*) BY AN EASTERN BLUE-TONGUE SKINK (*TILIQUA SCINCOIDES*)

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The Eastern Blue-Tongue Skink (*Tiliqua scincoides*) is generally recorded as omnivorous and opportunistic in its eating habits (Greer, 1989; Swan, 1990; Cogger, 2000). However, the consumption of relatively large frogs has not been reported. The following observation of such an event may or may not be typical behaviour.

OBSERVATION

On 14 December 2004 at 1500hrs, I saw a frog hopping rapidly across the middle of the lawn of my backyard hotly pursued by an eastern bluetongue about 40 cm long. I live at Kirrawee (34°10'S 151°04'E), a suburb just south of Sydney. Later I was able to see the frog was an Eastern Striped Marsh Frog (*Limnodynastes peronii*) which was approximately slightly over 10 cm in body length.

I rushed inside to get a camera and missed the next event, but on my return the frog was in the lizard's mouth, and the lizard beneath a bush close to where the pair had been moving when I first saw them.

The following photos show the resulting action. It consisted of a violent swinging of the frog from side to side in a series of sudden arc-like movements followed by intervals of inaction. The frog was swept low and dragged hard across the ground in this movement. The frog was bleeding but otherwise alive and intact. This behaviour continued for about 15 minutes and then the lizard moved away. At this point, a larger bluetongue stole the frog and both lizards went off into thicker undergrowth where I abandoned my observations.

At the time, the weather conditions were dry, sunny and warm (temperature 28°C). There are numerous Marsh Frogs in my backyard although I have never observed them moving during the day unless disturbed.

DISCUSSION

The habitat of bluetongues would appear to commonly overlap with frogs at times but the pursuit of a prey item I saw is at odds with the normally placid foraging behaviour of this lizard. The other curious matter was the apparent difficulty in breaking the frog up into portions that could be swallowed. At the rate I observed, the complete subjugation would have required many minutes of high-energy work. In addition, it created a large amount of noise which attracted a larger predator. This other predator might well have been more dangerous to the bluetongue than a larger individual of the same species. For these reasons it seemed to me a relatively dangerous and unproductive type of preda-tion.

Given these apparent drawbacks I am uncertain as to whether my observation is of typical species behaviour or the one-off act of a particularly hungry individual.

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BEHAVIOUR OF *LEPIDODACTYLUS LUGUBRIS* ON HERON ISLAND, GREAT BARRIER REEF, AND A RECORD OF *GEHYRA DUBIA* FROM THAT ISLAND

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INTRODUCTION

The present paper reports on two species of geckos, *Lepidodactylus lugubris* and *Gehyra dubia*, that have now become established on Heron Island (23°25′S 151°55′E) in the Capricorn Group, near the southern end of the Great Barrier Reef, and provides information on the behaviour and reproduction of *L. lugubris*.

Other lizards with breeding populations in the Bunker-Capricorn islands are two skinks, *Eulamprus tenuis* and *Cryptoblepharus virgatus* on Lady Elliot Island and the gecko *Hemidactylus frenatus* on Wilson Island (Heatwole et al., 1984, 1993); the remaining nine islands in the group are devoid of lizards.

METHODS

During the period of 3-10 August 2001, the walls of three buildings at the Heron Island Research Station, each 7.4 m x 6.7 m, were searched for geckos every evening between 1700 hrs and 2300 hrs. Air temperature was recorded several times during each observation period. During the day, crevices in the buildings were examined for eggs. The body length (snout to vent), gender, and presence or absence of oviductal eggs of each animal captured were recorded. Attempts were made to capture all geckos observed. Individuals were numbered (felt-tipped pen on pectoral region) to facilitate future recognition. They were then released at their sites of capture. The location and time of capture were recorded for the initial capture and all subsequent recaptures.

Because of the terms of the research permit, no voucher specimens were preserved.

RESULTS AND DISCUSSION

Geographic Distribution

The Mourning Gecko, *Lepidodactylus lugubris*, occurs widely throughout the Indo-Pacific region. Its distribution in Australia and recent colonisation of Heron Island have been reported by Limpus et al. (1999).

Gehyra dubia was also recorded on Heron Island. This species is widespread in eastern Australia, from Cape York Peninsula south to central New South Wales (Cogger, 1995). This is the first confirmed record for this species, although a suspected sighting was made in early 1997 (Limpus et al., 1999).

Other lizard species have also been seen on Heron Island. Personnel from the Heron Island Research Station occasionally have reported solitary individuals of skinks and dragons, and a small population of skinks persisted briefly around the grounds of the Research Station (Heron Island Research Station staff, personal communication). These lizards probably were introduced in supplies emanating from the port of Gladstone on the adjacent mainland, and never became established.

Population

There were 160 sightings of *Lepidodactylus lugubris* on the buildings at the Heron Island Research Station; 63 individuals were marked, of which 21 were recaptured one or more times. The smallest individual found was 17 mm snout-to-vent (SVL) and the largest was 51 mm; obviously there was a breeding population, as sexual maturity is reached around 41 mm SVL (Limpus et al.,

1999) and both eggs and young were found in the marked lizards. Of the 63 females that were captured, 46 (73%) were of adult size; of these, 30 (65.2% of the adults) were gravid. Twenty-four females (80% of the gravid females) had two eggs visible and six (20%) had only one. The mean snout-to-vent length (SV) of females with two eggs was 44.5 mm, and was not significantly different from the mean value of 44.1 mm for those with only one egg (Mann-Whitney U test; P = 0.859). The size range of non-gravid females was 17-49 mm SVL, nearly the total size-range of the population. Limpus et al. (1999) found very similar results, their findings differing only in a higher percentage of gravid females.

Twenty eight geckos (including four juveniles) were captured on building D1. These included six recaptures. Buildings D2 and D3 had 19 geckos (7 recaptures, one twice) and 17 geckos (8 recaptures, two twice) respectively. Included in the captures for D3 were one G. dubia and two juvenile L. lugubris. Using the Lincoln-Peterson method, with the Chapman modification, the estimated population for all three buildings was 98 ± 13 geckos with a 95% confidence interval (Pollock et al., 1990). For buildings D1, D2, and D3, the estimated populations were 51 ± 13, 25 ± 29, and 19 ± 17, respectively.

A total of 38 eggs was found. Two were attached to a flat surface, but the rest were in crevices (9-22 mm in depth) in the buildings. Numbers of eggs in the same crevice ranged from one to eight (mean = 2.7 ± 1.8); since the maximum clutch size in this species is two, females must often nest communally. There were eight nests found on D1, with a total of 25 eggs. Only two nests were found on D2, and a total of six eggs. Three nests were found on D3 with a total of seven eggs.

Activity

During the day geckos were observed only in crevices or under sheeting of the roof. At about 1700 hrs geckos began leaving their crevices. During the first hour many were observed on the walls and roofs, but there-after numbers waned to only a few individuals who sustained activity into the night. The decline in numbers on the buildings was not because of cessation of activity, but because many of the lizards moved from the buildings onto adjacent Pisonia trees. Each night animals lined up, with as many as five individuals in a row, along the edge of a roof where there was a nearby limb of a Pisonia tree. They would, in turn, leap distances up to 40 cm from the roof onto the tree, and then move out to forage on the limbs and foliage. This occurred on four different buildings where a Pisonia tree was nearby. As for the geckos that were not close to a Pisonia tree, they remained active on the back wall and the side of the building opposite the local Pisonia tree. These geckos were usually seen close to the roof, where they could escape quickly. Observations were discontinued after about 2300 hrs and the geckos' return from the trees was not observed. However, a single gecko was observed on the side of a building at 0500 hrs. By 0600 hrs the geckos had returned to their daytime retreats. After their nocturnal forays the animals returned to their original building; no marked animal was ever found on any building but the one from which it was originally captured and marked. Thus, these lizards seem to confine their activities to specific home ranges and show high fidelity to a particular site.

Temperatures recorded during nocturnal activity ranged from 15° to 18.5°C.

Predation

The only observed predation on Lepidodactylus during the present study was by a reef egret at 0545 hrs. The bird was seen behind one of the buildings with an adult Lepidodactylus in its bill, which it promptly swallowed. Lepidodactylus readily autotomizes its tail when attacked. Despite this, only one gecko was observed with a regenerated tail, suggesting either that predation is infrequent, or is so effective that few individuals escape. The low incidence of regrown tails is consistent with the observations of Limpus et al. (1999).

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A HIGH ALTITUDE OBSERVATION OF THE NORTH QUEENSLAND PYGOPOD
DELMA LABIALIS (SAURIA: PYGOPODIDAE)

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INTRODUCTION

Very little is known about the pygopod lizard *Delma labialis* as few observations or specimens have been documented in the literature.

The known distribution of *Delma labialis* is confined to two small, geographically isolated regions in the central coast of Queensland, from Keswick Island in the south to coastal northeastern Queensland, as far north as Paluma (Wilson & Swan, 2003; Wilson, 2005). Documented observations have recorded individuals at, or close to, mean sea level (Low, 1978; Shea, 1987). Those individuals observed close to the northern range extent have only been recorded in the foothills below Paluma (Wilson, 2005), the holotype being collected on the Bruce Highway at the Paluma turnoff (Shea, 1987).

Activity times have also been poorly documented. Low (1978) noted three individuals, recorded as *Delma inornata* (?), from Magnetic Island, north Queensland in August 1976, one individual being active at midday on an open, dry, rocky hill, the other two found under tin in open forest. Shea (1987) also reported two individuals of the species on Magnetic Island, in February 1985, as active during the day in wet sclerophyll forest and open woodlands. Wilson and Swan (2003) also describe this species as diurnal. Apart from this, nothing is known of its biology and it is currently listed as Vulnerable (Cogger *et al.*, 1993; Wilson and Swan, 2003).

This paper documents a high altitude observation of the species and further describes diurnal activity and habitat use.

OBSERVATIONS

On 29 June 2004, at 1545 hrs, an individual *Delma labialis* (Figure 1) was observed crossing the Mt Spec Forestry Road near Paluma Dam within Paluma Range National Park, north Queensland (18°59'10"S 146°10'06"E) at an altitude of 750 m above sea level. The individual was located on an unsealed road, less than one kilometre south of the Paluma Dam picnic area. The vegetation profile in this area consisted of a gradient from simple notophyll vine forest to tall sclerophyll forest. Simple notophyll vine forest in this area consists of many plant species, however, the roadside vegetation is dominated by *Acacia melanoxylon*, and the tall sclerophyll forest is dominated by *Syncarpia glomulifera, Eucalyptus grandis* and *A. melanoxylon*. The patch of road was void of any direct sunlight, due to the high density of the upper canopy, although there was approximately 40% light cloud cover above the canopy. Weather conditions were quite cool. The ambient temperature was 18°C.

The individual was sighted from a vehicle while heading north along the unsealed road. I, along with several passengers, noticed a 'snake-like' animal appear from the road verge (on the western edge) moving eastwards at a considerable speed. The individual resembled a Collared Whip-snake *Demansia torquata*, which are quite common in the area (pers. obs.). I managed to pull the car off to the side and approached the individual, treating it as though it was an elapid snake. A closer inspection revealed the subject to be a *Delma labialis* (snout-vent length 114 mm; tail length 460 mm; sex not determined). The lizard was positively identified using Wilson and Swan (2003) and Cogger (2000).

DISCUSSION

Diurnal activity in *Delma labialis* has been reported on three occasions (Low, 1978; Shea, 1987) and the current observation supports the view that *D. labialis* is routinely active during daylight hours. *Delma labialis* has been recorded in a variety of habitats including rocky hillsides, open forest/woodland and wet sclerophyll forest (Low, 1978; Shea, 1987) at elevations between mean sea level (Low, 1978) and 750 m (this paper).

This individual reported here was observed on the boundary of a vegetation gradient between simple notophyll vine forest and tall sclerophyll forest, increasing the range of habitat tolerances known for the species.

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Figure 1. *Delma labialis* from Paluma Dam
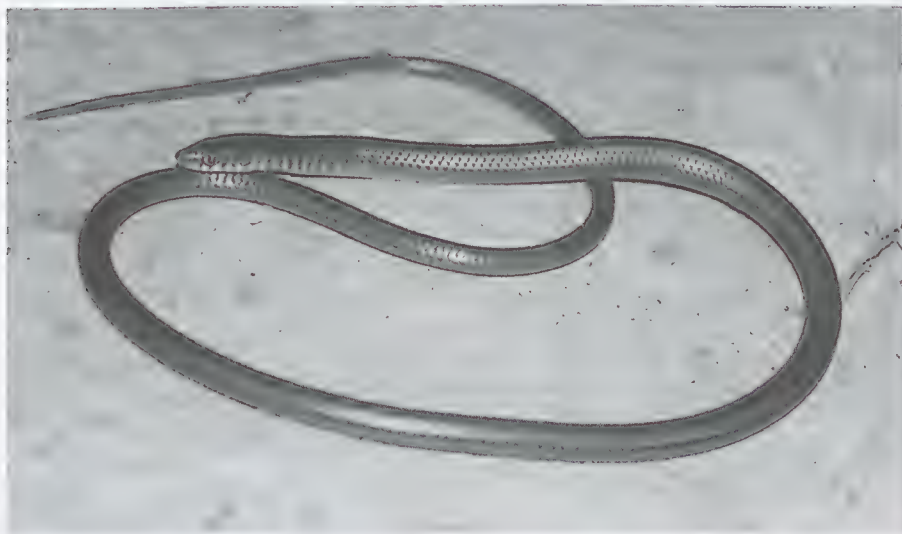
EVIDENCE FOR CAUDAL LURING IN A CAPTIVE WATER PYTHON (*LIASIS FUSCUS*)

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INTRODUCTION

Caudal luring is a behaviour used by a number of snake species to attract prey close enough to ensure an active strike from an ambush position. For this reason, it is most often associated with "sit and wait" predators, such as the elapid genus *Acanthophis* (Chiszar *et al.*, 1990). Death Adders (*Acanthophis* sp.) display the most advanced caudal luring behaviour of Australian species, possessing a coloured tail tip that is wriggled or writhed to entice prey (Chiszar *et al.*, 1990; Carpenter *et al.*, 1978).

Two species of Australian python have also been documented to utilise caudal luring. Barker and Barker (1994) state that Green Pythons (*Morelia viridis*) of all ages will caudal lure in captivity, although this is most common in juveniles. This behaviour is usually demonstrated when food is in view, although hungry individuals may wriggle their tails in anticipation (Barker & Barker, 1994). Caudal luring has also been observed in captive Womas (*Aspidites ramsayi*), particularly when prey movement is detected close to the snake (Fyfe & Harvey, 1981; Barker & Barker, 1994). It is suspected that wild Womas also demonstrate this behaviour due to the large number of museum specimens with missing tail tips (Kluge, 1993).

Although most species of Australian python are currently maintained in captivity, to my knowledge no other species have been recorded to utilise caudal luring. This paper reports this behaviour in a captive Water Python (*Liasis fuscus*) held in a private collection in western Sydney.

OBSERVATION

At 1830 hrs on 21 July 2000, an adult King Quail was introduced into the enclosure of an adult female Water Python, held in a private collection in western Sydney. The Water Python was 1.68 metres in length and weighed 2.35 kilograms. The snake had been in captivity for at least three years and had not fed for three weeks prior to this observation. Upon releasing the quail into the enclosure, the python, which had not previously been fed a live meal, initially appeared frightened, not displaying any predatory behaviour.

After approximately two minutes, the snake appeared to become interested, markedly increasing its rate of tongue flicking. It lay quite still, positioned with its tail tip within 15 cm of its head, wriggling the final 6-7 cm of its tail. The tail was moved in a slow, continuous, undulating manner. Although the quail did not display any specific interest in the tail movement, the snake continued this behaviour, curiously tongue-flicking at the rear of the quail whenever it came within reach. Upon the third time that the quail approached the tail of the snake, it was struck and constricted; the tail writhing ceased immediately.

DISCUSSION

Although caudal luring has been documented in at least two species of Australian python, it has not previously been recorded in *L. fuscus* (Murphy *et al.*, 1978; Fyfe & Harvey, 1981; Barker & Barker, 1994). Under natural conditions, *L. fuscus* is principally an ambush predator, feeding on a variety of small vertebrates including birds (Shine, 1991). Hence, the caudal luring noted in captivity may be

occasionally demonstrated by wild snakes, though is likely to be difficult to observe.

The Water Python observed here had been maintained in captivity for at least three years. During this time, it was fed a diet consisting solely of dead mice and rats, and did not display any behaviour resembling caudal luring. On introducing the live quail, the snake initially appeared to be startled, and tail movements did not begin until an interest in the prey was observed. Hence, the behaviour reported was not consistent with a defensive threat as described (Heard, 2003) for the Red-bellied Black Snake (*Pseudechis porphyriacus*). Instead, the observation of tail writhing appears to be a direct response to the stimulus of live prey within the enclosure. The continual movement of the quail prior to and during the tail writhing suggests that the behaviour was not a prey-scaring function as observed in some elapid genera, including *Demansia* and *Drysdalia* (Scanlon, 1998). Thus, I interpret this Water Python as using the tail to attract potential prey within range of a strike from ambush.

ACKNOWLEDGMENTS

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A RANGE EXTENSION FOR THE SPINIFEX SNAKE-LIZARD *DELMA BUTLERI* (PYGOPODIDAE) : A RECORD FROM THE MURRUMBIDGEE IRRIGATION AREA, NEW SOUTH WALES

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Delma butleri (Pygopodidae) is generally regarded as being restricted to areas of spinifex with a mallee over-storey (Sadlier & Shea, 1989; Val *et al.*, 2001; Swan *et al.*, 2004). The species has been recorded throughout Western Australia, South Australia, Victoria and New South Wales (Cogger, 2000). In New South Wales, records for *Delma butleri* are few. Most records are in in central western NSW and in the far south-western corner of the state (Fig. 1) (Sadlier & Shea, 1989; Val *et al.*, 2001; NPWS, 2004; Swan *et al.*, 2004). This short note records, for the first time, the presence of *Delma butleri* in the Murrumbidgee Irrigation Area (MIA) in the Riverina region of NSW, which represents a 150 kilometre southerly range extension (Figure 1).

The habitat of *Delma butleri* in NSW has been highly altered and fragmented as a result of land clearing, live stock grazing and altered fire regimes. Since the 1960s over ninety percent of mallee habitat has been cleared or

Figure 1. Records of *Delma butleri* in New South Wales, including the new record in the Murrumbidgee Irrigation Area.
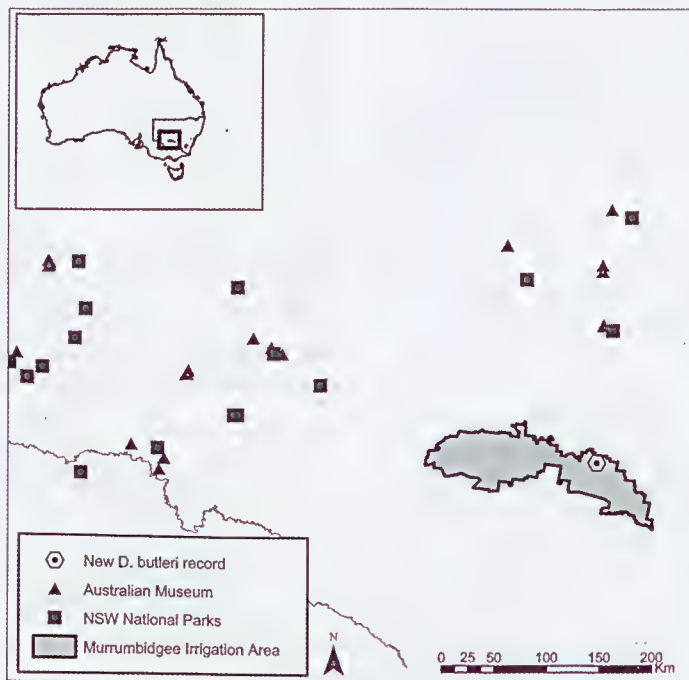
Figure 2. One of the *Delma butleri* found near Griffith, New South Wales (Photo: G. Swan)

Figure 3. Mallee vegetation with a spinifex understorey where *Delma butleri* were found near Griffith, New South Wales (Photo: S. Sass)

degraded in NSW (Jacobs, 1989). In the MIA, the remaining mallee remnants occur as small linear remnants along roadsides and railway lines as well as small patches on private land (Cameron, 2002; Eldridge, 2002). Mallee is not well represented in the conservation reserves of the region with only two small reserves containing mallee in the Griffith area both containing smaller pockets of spinifex (J. Brickhill, pers. comm.). All areas of mallee vegetation in the Griffith area exist as isolated habitat patches within a highly fragmented and modified agricultural landscape where cereal cropping and horticultural activities such as rice and grape production are the dominant industry.

During biodiversity surveys conducted for Murrumbidgee Irrigation, five *Delma butleri* were found on 22 November 2003 during active hand searches of spinifex grass within a 52 hectare mallee site (413827E 6216105N) near Griffith, New South Wales (Fig. 2) (Sass *et al.*, 2004). Pygopod sloughs and eggs were also found during the survey.

The remnant vegetation consisted of *Eucalyptus dumosa* and *E. socialis* with an understorey of mallee broombush (*Melalueca uncinata*) (Fig. 3). The most common ground cover is porcupine grass (*Triodia scariosa*). Other ground covers include spreading flax lily (*Dianella revoluta*) and feather speargrass (*Austrostipa elegantissima*). The study site was cleared in its entirety around 20 years ago for the expansion of a vineyard (L. Harrison, pers. comm.) which did not eventuate. The vegetation at the site is now the result of natural regeneration. The study site is surrounded by extensive horticultural activity such as vineyards (south and west) and dryland wheat cropping (north and east). A narrow windbreak of remnant mallee devoid of spinifex (<10 m width) connects the remnant to a larger mallee remnant with scattered areas of spinifex (146 ha) to the north-east about 300 metres from the study site.

The presence of *Delma butleri* within a 20 year regeneration site suggests that this species may be able to disperse over consid-

erable distance through areas devoid of spinifex to newly regenerated or restored habitat. Further research is needed to establish the effects of habitat fragmentation on reptile fauna within the MIA.

This record of *Delma butleri* within the MIA suggests that their natural distribution in NSW is greater than was previously thought. The occurrence of a spinifex obligate species in a relatively small remnant (52 ha) demonstrates the importance of these areas in maintaining regional biodiversity within a predominantly agricultural landscape.

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ACCIDENTAL INGESTION OF BARBECUE SCRAPS LEADS TO DEATH OF A VARANID IN THE NORTHERN TERRITORY

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INTRODUCTION

Interactions between humans and herpetofauna can have fatal consequences for the herpetofauna. Invariably, humans leave items of rubbish, which can be fatal by one of two categories. The first includes those items that are directly fatal, such as plastic netting, which has been reported to kill snakes (Stuart *et al.*, 2001) and turtles (Cann, 1998; Starbird & Audel, 2000), and plastic bags that are ingested by sea turtles (Fritts, 1992) leading to intestinal blockage and subsequent death (Mrosovsky, 1987). The second includes items that are regarded as "harmless" but, indirectly, can lead to the death of the animal. Dead snakes (Herrington, 1985) and monitor lizards (Vincent & Wilson, 1999) have been found in soda cans after becoming trapped while searching for food and/or shelter. Even some of the most unlikely objects, such as the tops of milk cartons (Dietz & Ferri, 2003), nylon bands (Odum, 1985) and rubber o-rings (McLeod, 1994), have been reported to disfigure freshwater turtles if they become entangled. In this paper we present evidence of one of these "harmless" items that may have caused the death of a varanid lizard.

OBSERVATIONS

On 11 July 2004 while conducting studies on tropical snakes we went for a brief walk through the barbecue area at Wangi Falls, Lichfield National Park, Northern Territory (13°09'48"S 130°41'00"E). While there, one of us (DT) spotted a dead varanid lizard (1.5 m total length) adjacent to the grassy picnic area. It was not possible to identify as it was in an advanced state of decay, but it must have either been *Varanus gouldii* or *V. panoptes* as these are the only large monitor lizards present in the area. The monitor lizard was lying on its stomach and when turned over a closer inspection revealed that inside the rib cage were three 35 cm long wooden sticks. The wooden sticks were similar to the skewers that people use to barbecue meat. The skeleton, as it was complete, was collected for deposition in the Northern Territory Museum and Art Gallery.

DISCUSSION

In Australia, varanid lizards are a common inhabitant of campsites and picnic grounds with *Varanus varius* present along the east coast, replaced by *V. gouldii* and *V. panoptes* in the northern areas (pers. obs.). Varanid lizards such as *V. varius* have a generalised carnivorous diet (Guarino, 2001) which, combined with a highly developed sense of smell, would allow them to find barbecue scraps an easily-located renewable resource.

This observation suggests that the varanid consumed barbecue skewers that were left at the picnic ground. The possibility exists that the skewers were placed inside the varanid after death, but as it was found lying belly-down and did not appear to have been disturbed since death we consider this possibility highly unlikely. The skewers presumably pierced the stomach or intestine wall and killed the individual. Unfortunately the carcass was decomposed so the exact location of the skewers in the body cavity could not be determined. Varanid lizards may be susceptible to death from ingesting sharp objects. An adult *V. giganteus* was found dead after it had tried to consume an echidna

(Longman, 1912), with death occurring after the sharp spines of the echidna lodged in its mouth. In ending, though, this note should help to spread awareness about proper barbecue etiquette, and to also show that even innocuous items can contribute to the death of our local herpetofauna.

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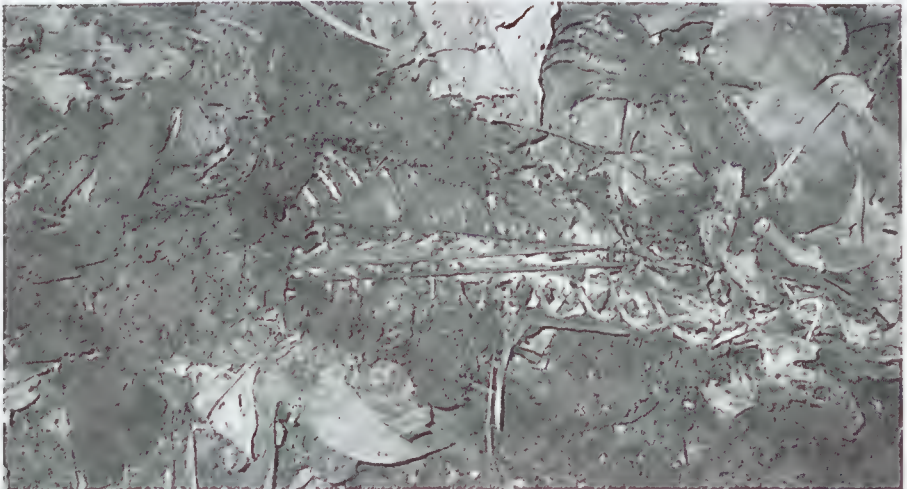
DIPTERAN INVASION OF GREEN SEA TURTLE (*CHELONIA MYDAS*) NESTS AT HERON ISLAND, QUEENSLAND

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There have been several reports of insect infestations of sea turtle nests, usually by larvae of the dipteran family Phoridae (Fowler, 1979; Bjorndal *et al.*, 1985; Broderick & Hancock, 1997; McGowan *et al.*, 2001) and Sarcophagidae (Lopes, 1982; Broderick & Hancock, 1997; McGowan *et al.*, 2001), but also infrequently by coleopteran larvae (Baran & Turkozan, 1996; Broderick & Hancock, 1997; McGowan *et al.*, 2001) and Hymenoptera (Broderick & Hancock, 1997). These reports have come from green turtle (*Chelonia mydas*) nests in Costa Rica (Fowler, 1979), Mexico (Lopes, 1982) and Cyprus (Broderick & Hancock, 1997); hawksbill turtle (*Eretmochelys imbricata*) nests in Costa Rica (Bjorndal *et al.*, 1985); and loggerhead turtle (*Caretta caretta*) nests in Turkey (Baran & Turkozan, 1996) and Cyprus (Broderick & Hancock, 1997). There have been no published reports of insects in Australian sea turtle nests.

In the 1996/97 and 1997/98 nesting seasons green sea turtle (*Chelonia mydas*) nests at Heron I. (23°26'S 151°55'E) were located after hatchling emergence and excavated according to procedures by described by Phillott (2002). Larvae were found in eggs that had failed to hatch, pipped eggs containing dead embryos, and emerged hatchlings remaining in the egg mass (see Table 1). Fly larvae were detected in 22% of nests in 1996/97 (n=88) and 28% of nests in 1997/98 (n=109). Attempts to raise the larvae to adulthood were unsuccessful, so identification was not possible. Newly emergent adults of *Australopierretia australis* (Diptera: Sarcophagidae) were isolated from the substrate of two nests in 1996/97 and one nest in 1997/98. These three nests also contained unidentified dipteran larvae. The location of the adult flies within the substrate as the nest was excavated indicates they represent at least some of the larvae present and were not incidental animals attracted to the nest as it was exposed.

Australopierretia australis is widespread on the Australian mainland and in the south-west Pacific but has not been previously associated with sea turtles (D.H. Colless, pers. comm.). Sarcophagids are almost all viviparous, and larvae of most Sarcophaginae, the subfamily to which *Australopierretia* belongs, are usually detritus feeders in soil, carrion or other decomposing organic matter (Colless & McAlpine, 1991). However, a few species are known to be parasites of grasshoppers, while others live in spider egg-cases where they feed on the developing eggs, and some have been reared from insects and snails and are considered to be necrophages (Colless & McAlpine, 1991).

The means by which sarcophagid flies invade turtle nests has not been conclusively demonstrated. It is believed that active, first instar larvae are oviposited at the beach surface by the viviparous female (Broderick & Hancock, 1997) then burrow through the sand (Vogt, 1981; Lopes, 1982). Nests are presumably located by the female fly by olfaction (Vogt, 1981), and adults are often seen flying immediately above the sand surface in the dunes at Heron I.

Penetration of the egg is likely to occur by chewing (Iverson & Perry, 1994) or the production of proteolytic enzymes as in the Phoridae (Acuña-Mesén & Hanson, 1990). None of the four species of sea turtles investigated (loggerhead, green, flatback and hawksbill)

Table 1. Observations of Diptera Larvae in Green Sea Turtle Nests at Heron Island

Season	1996/97		1997/98	
	Occurrence of Larvae		Occurrence of Larvae	
	Mean±SD (range) per Infested Nest	# Infested Nests	Mean±SD (range) per Infested nest	# Infested Nests
# Infested Unhatched Eggs	0.94±1.24(0-5)	14	0.46±0.59(0-2)	10
# Infested Pipped Eggs	0.13±0.34(0-1)	2	0.75±0.79(0-3)	15
# Infested Dead Neonates	0.06±0.25(0-1)	1	0.13±0.61(0-3)	1
Total # Infested Nests	16		24	
Total # Nests Examined	88		109	

possess discrete eggshell pores to act as portals (Phillott, 2002). Flies pupate within the turtle egg (Acuña-Mesén & Hanson, 1990) and emergence probably occurs through the small hole left during penetration (Iverson & Perry, 1994).

Whether the larvae act as necrophages (attacking non-viable eggs) or parasitoids (predating on developing embryos) is uncertain. Invasion of viable eggs possibly occurs only after attraction to decomposing matter (Broderick & Hancock, 1997). Larvae were found in the body of live hatchlings, presumably having entered through residual yolk at the umbilical region. This is also the route by which most embryonic tissue is attacked (pers. obs.).

The 22-28% infestation rates of green turtle nests by dipteran larvae at Heron I. in 1996/97 and 1997/98 can be compared to variable infestation rates of green turtle nests on northern Cyprus: 5% in 1995 (Broderick & Hancock, 1997), 3% in 1996 and 20.7% in 1997(McGowan et al., 2001). McGowan et al. (2001) attributed temporal variation in infestation rates in northern Cyprus to be a result of changes in methodology: in 1995 and 1996, nests were excavated within 24 hrs of the first hatchling emergence whereas in 1997 nests were not excavated until 48 hrs after the last hatchling had emerged. In the current study, nests were excavated within 24 hrs of the majority of hatchlings emerging from the nest. As individuals or small groups may precede emergence of the main group of hatchlings (Witherington et al., 1990) the timing of nest excavation in the current study is likely to fall between that of the different methodologies used by Broderick and Hancock (1997) and McGowan et al. (2001) in northern Cyprus. Vásquez (1994, as cited in McGowan, 2001) demonstrated that the likelihood of nest infestation increased with delay between hatchling emergence and nest excavation, so this must be taken into account when comparing infestation rates between rookeries and determining the influence of larval infestation of sea turtle nests on hatch success. The finding that occurrence of larvae increased with time after hatchling emergence suggests that at least one of the fly species is a necrophage and attacking unhatched eggs or hatchlings remaining in the nest.

McGowan *et al.* (2001) determined that infestation of loggerhead turtle nests occurred both pre- and post-emergence of hatchlings, but only post-emergence for green turtle nests in northern Cyprus. The presence of adult *A. australis* in green turtle nests at Heron I. indicated definite infestation prior to hatchling emergence, and as the life cycle of sarcophagids is completed within 13-25 days dependent on temperature (see McGowan *et al.*, 2001), larvae must have finished burrowing to the turtle nest 2-3 weeks prior to nest excavation.

I have found similar larvae, but no adults, in green turtle nests at Wreck I. (23°20'S 151°57'E), loggerhead turtle nests at Heron I., Wreck I. and Mon Repos Conservation Park (24°48'S 152°27'E), and hawksbill turtle nests at Milman I. (11°10'S 143°00'E). Infestation rates in these nests have not been quantified. No adult or larval Diptera were found in flatback turtle (*Natator depressus*) nests examined at Peak I. (23°20'S 150°56'E); 50 nests were examined so the absence of Diptera from within nests at Peak Is. is not an artefact of low sample size. Vogt (1981) observed a greater occurrence of dipteran larvae in freshwater turtle nests in years of relatively high rainfall. High beach temperatures and severe moisture stress conditions experienced by flatback turtle nests at Peak I. (Hewavisenthi, 1999) are the most likely contributory cause for absence of larvae from nests at this beach.

The potential for insect invasion of sea turtle nests to reduce hatch success (in addition to their effect on moribund eggs), and environmental factors influencing the frequency of invasion requires further investigation.

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ADDITIONAL INFORMATION ON *MENETIA SADLIERI*, A POORLY KNOWN SKINK FROM MAGNETIC ISLAND, NORTH QUEENSLAND

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INTRODUCTION

Menetia sadlieri is a small skink restricted to Magnetic Island, North Queensland. Until recently, *M. sadlieri* was only known from the holotype (QMJ24448) held at the Queensland Museum, collected by Tim Low in July 1974. According to Greer (1991) the holotype is probably the individual attributed by Low (1978) to *M. timlowi*, that was found "under stone in [a] well-shaded rocky gully". Recently, a second specimen of *M. sadlieri* came to light. This was registered in the Queensland Museum collection in August 2003 as QMJ79858. This specimen was collected on 22 July 1977 from West Point, Magnetic Island as part of a fauna survey conducted by Queensland Parks & Wildlife Service (Pallarenda).

Menetia sadlieri is poorly known. From the capture of the holotype and QMJ79858 to the capture of subsequent individuals, it enjoyed over 20 years of obscurity. In the most recent comprehensive guide to Australian reptiles, Wilson and Swan (2003), it is one of only 8 species (of 377) of skinks listed as having no available image of a live specimen. They state that its "inclusion within *Menetia* is tentative; it may belong in a separate genus or within *Carlia*."

M. sadlieri is also one of only three known island endemic reptiles from Queensland (with *Lepidodactylus pumilus* and *Cryptophis incredibilis*, both from islands of Torres Strait).

This paper presents additional information about the holotype and QMJ79858, as well as information on subsequent live *M. sadlieri* that have been found and some reproductive information. It presents photographs of live adult *M. sadlieri* for the first time and provides notes on the habitats where they are known to occur.

LIVE INDIVIDUALS

Fauna surveys conducted in 1999 - 2000 recorded two individuals from pitfall traps at Bolger Bay Nature Refuge on the south western side of Magnetic Island. These were identified at the time as *M. sadlieri* on the basis of their enlarged upper palpebral scales and their upper pretemporal scale configuration, which matched the description in Greer (1991) (A. Kutt, EPA, Pallarenda; pers. comm.). These were subsequently released and represent the first records of *M. sadlieri* since its collection in 1977.

In November 2003, I captured a tiny skink in a back yard in Nelly Bay on the south east side of the island. On the basis of its enlarged upper palpebral scales and pretemporal scale configuration this was identified as a juvenile *M. sadlieri*. This skink was measured, photographed and released where it was captured. Subsequently, from the same yard, 11 individuals have been captured, identified and measured, photographed and released. All were released except one which was sent to the Queensland Museum and is registered as QMJ81662. *Menetia sadlieri* has been observed (but not captured) at least another 20 times at this location and along a nearby creek line and in Arcadia.

In February 2004 a gravid female *M. sadlieri* was captured and identified in Arcadia. All reproductive data presented, the first such data for the species, relate to this specimen.

Length measurements of all captured individuals and the three Queensland Museum specimens are presented here.

Table 1. Lengths of *M. sadlieri* (SVL = snout to vent length). Lengths in mm.

Specimen/Location	SVL	Tail Length	Total Length
Holotype (QMJ24448) . measurements from Greer, 1991	22.5	28.5 (7 mm regenerated)	51
QMJ79858	22	20 (partially regenerated)	42
Nelly Bay (QMJ81622)	24.6	18.3 (partially regenerated)	42.9
Nelly Bay	16.5	18	34.5
Nelly Bay	25.5	17.5 (partially regenerated)	43
Nelly Bay	27	10 (4.5 mm regenerated)	37
Nelly Bay	23.5	29.5	53
Nelly Bay	17	5 (1 mm regenerated)	22
Nelly Bay	17	23	40
Nelly Bay	14	16.5	30.5
Nelly Bay	27.5	23 (12 mm regenerated)	50.5
Nelly Bay	27.7	20.3 (13.3 mm regenerated)	48
Nelly Bay .	20	27.5	47.5
Arcadia	27.9	19.5 (3.5 mm regenerated)	47.4

DESCRIPTION IN LIFE

For general descriptions of *Menetia* see Cogger (2000) and Wilson and Swan (2003). For specific scale counts of *M. sadlieri*, see Greer (1991). The suite of characters warranting the inclusion of *sadlieri* within *Menetia* as defined in Greer (1991) holds true for the individuals examined.

The diagnostic scalation around the eyes of *M. sadlieri* as presented in Greer (1991) largely holds true for QMJ79858 and the 12 measured individuals. On the right side only, the upper pretemporal scale largely obscured the lower in one of the juvenile Nelly Bay individuals (see Figure 1). In all other respects, including its left pretemporals, this skink was as shown in Greer (1991).

Measurements of *M. sadlieri* with full original tails (not regenerated) suggest an average tail

length to S-V length ratio of 1.25:1. Using the S-V length of the largest individual as a guide, this suggests a maximum total length around 63 mm.

The dorsal colouration is light brown to bronze, fading slightly towards the upper dorsolateral region (see Figure 2). In some individuals this gives the appearance of a pale dorsolateral stripe (as mentioned in both Cogger, 2000 and Wilson and Swan, 2003). In some large individuals this stripe is quite prominent, particularly over the shoulders and hips, extending almost the length of the tail, or to the point of regeneration on the tail. In other specimens it is faint and restricted to above the hind legs. There are occasional irregular dark brown spots on the dorsum in two individuals.

In three of the Nelly Bay skinks, the top of the head is darker than the rest of the dorsum,

Figure 1. Head scalation of juvenile Nelly Bay *M. sadlieri*, right side. Dotted line shows 'typical' pretemporal (pt) configuration (as shown in Greer, 1991). Bold line shows pretemporal configuration in juvenile (adapted from Greer, 1991).
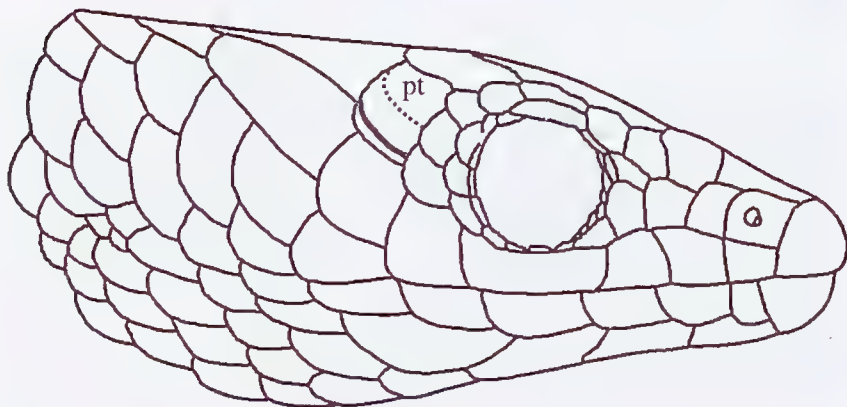

Figure 2. Typically coloured adult *M. sadlieri* from Nelly Bay.

with irregular darker blotches, which fade in the nuchal region. In the others, the top of the head and body are the same colour.

There is an abrupt demarcation between the lateral and dorsal colouration along the upper lateral zone. This is delineated by a row of scales along the body bearing dark blotches that line up in a series to form a dark line from the nape to the tail. Laterally, the scales are dark brown, fading towards the belly; very dark brown in the juveniles (see photograph in Wilson, 2005: 144) but paler in the adults, with the centre of each scale having a darker longitudinal blotch, tending to align to form obscure stripes along the flanks. The dark brown on the flanks extends forward through the eye to the nasal scale, and backwards the length of the original tail. A single line of gold/bronze spots is present on the lower lateral surface of the original tail in one individual. The dorsal surface of the original tail is grey/brown with numerous light and dark flecks, giving a 'salt and pepper' appearance.

On the face, the dark colouration is broken on the supralabial scales by broad, vertical, pale bars posterior to each scale suture.

The infralabials have dark blotches on a pale background. The ventral surface is cream to white, with regular dark spots on the belly scales, which line up into thin, faint, longitudinal lines. The chin is cream to white and patternless. The legs are dark brown, and may or may not have sparse flecks of bronze.

HABITAT

Magnetic Island is centered about 19°08'00"S 146°49'15"E. The holotype was collected under a rock within a gully just off the Horseshoe to Balding Bay walking track (Figure 3). It was found from the middle to upper part of the rocky gully in the Balding Bay watershed, amongst dry rainforest growing over boulders (Tim Low, pers. comm.). The altitude, extrapolated from the Department of Natural Resources (1997) topographic map would have been no

greater than 60 m. Latitude and longitude would have been within the rectangular area bounded by 19°06'43.8" - 19°06'51.9"S and 146°52'08.4" - 146°52'09.2"E.

The locality of QMJ79858 notwithstanding, all known *M. sadlieri* were found in lowland parts of the island. The holotype was found in somewhat different habitat from more recently found individuals, which have all been on "flats" rather than rocky slopes which are dominant over most of the island.

Habitat information provided below for Bolger Bay Nature Refuge individuals is from Morgan and Terrey (2001) and from personal communication with G. Morgan. One Bolger Bay Nature Refuge individual was captured in "plains on sandy outwash with eucalypt woodland" (Morgan & Terrey, 2001). Bloodwoods (probably *Corymbia clarksoniana*) and poplar gums (*Eucalyptus platyphylla*) dominate the canopy with occasional weeping tea tree (*Melaleuca leucadendron*) and pandanus (*Pandanus whitei*) in the understorey. There is a diverse and dense ground cover including grasses (e.g. Spear grasses, *Heteropogon* spp.), flax lilies (*Dianella* spp.), native wandering jew (*Commelina* spp.) and Polynesian arrowroot (*Tacca leontopetaloides*). The soil surface is relatively hard. The other Bolger Bay Nature Refuge individual was captured in secondary dunes within bloodwood and poplar gum dominated woodland. The open ground cover includes various grasses, spider lilies (*Crinum* sp.), Polynesian arrowroot and scarlet bloodroot (*Haemodorum coccineum*). The soil has a loose, sandy surface.

The Nelly Bay individuals were from a backyard adjacent to Gustav Ck, within or adjacent to, very thick leaf litter. The floral assemblage is a highly modified one, with planted vegetation dominant. Thick leaf litter in which the skinks were found results primarily from a large beach hibiscus (*Hibiscus tiliaceus*), a poplar gum, heliconias and garden mulch. Lawn grasses and guinea grass (*Panicum maximum*) also provide some cover. The individual observed in the creek line was

Figure 3. Dry rainforest growing over granite boulders typical of the area from which the holotype of *M. sadlieri* was collected.

Figure 4. Adult male *Carlia foliorum* (top) and *Menetia sadlieri* specimen (QMJ81622).

among bamboo leaf litter about 30 cm deep.

The gravid Arcadia individual was found in modified suburban environment, at the base of the granite hills beside the township. The microhabitat consisted of thick leaf litter, moderate canopy cover and exposed granite rocks. The other Arcadia individual was observed among thick weeping tea tree leaf litter in a dry swamp.

REPRODUCTIVE DATA

On 12 March 2004, the Arcadia individual laid a clutch of two eggs after 8 days in captivity. The post-oviposition mass of the female was 0.2048 g. Clutch mass was 0.0976 g. Clutch data is presented in Table 2. Despite an attempt to incubate them at a constant 23ºC both eggs failed to hatch.

Table 2. Clutch details for *M. sadlieri* eggs.

Specimen	Mass (g)	Length (mm)	Width (mm)
Egg #1	0.0494	7.14	3.18
Egg #2	0.0482	6.83	3.05

SIMILAR SPECIES ON THE ISLAND

In the probable absence of other *Menetia* species, there are very few skinks which are likely to be confused with *M. sadlieri* on Magnetic Island. With the combination of four fingers, five toes and unblinking, fused lower eyelids, *M. sadlieri* can be confused with only one other species recorded on the island: *Carlia foliorum*.

Carlia foliorum is distinguished by its lack of colour demarcation in the upper lateral zone, much greater leg length relative to body length (front and hindlimbs overlap when adpressed), relatively larger ear opening, greater overall size and overall darker and more uniform colouration. Adult male *C. foliorum* in Spring – Autumn usually have a vivid orange to red flush on their posterior, hind legs and tail which is largely absent from the observed *M. sadlieri*. One *M. sadlieri* collected (QMJ81622) on 15 October 2004 had an orange flush to the tail, but the hind leg colour was normal (Figure 4).

Young individuals of other *Carlia* species may be confused with *M. sadlieri*, but, if observed in natural habitat, can usually be distinguished by their tail-waving behaviour (absent in *M. sadlieri*) and obvious posturing; *Carlia* spp. will frequently perch in a promi-

nent position, stop, and wave their tails. *M. sadlieri* has not been observed to behave in this manner.

ADDITIONAL INFORMATION

Immature (deutonymph) mites of the family Uropodidae were collected from two of the Nelly Bay individuals. Specialised deutonymphal morphs of uropodid mites occasionally hitchhike on vertebrates or large arthropods such as beetles in the soil – they do not parasitise their "host", but rather use the host to transport them between suitable habitats such as rotting logs or other patches of decomposing material. They have a unique and instantly recognisable attachment mechanism consisting of an anal pedicel or stalk which is glued to the smooth outer covering of their chosen transport.

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descriptions of live specimens. Thanks also to Dr Andrew Amey and Patrick Couper (Queensland Museum) for guidance and allowing me access to the specimens held at the Queensland Museum. Thanks to Tim Low for providing additional information regarding the holotype, Alex Kutt and Gethin Morgan (EPA, Pallarenda) for habitat descriptions at West Point and to Matthew Shaw (Queensland Museum) for identifying and providing information on mites collected from *M. sadlieri*.

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A SECOND CASE OF BICEPHALISM IN QUEENSLAND CARPET SNAKES (*MORELIA SPILOTA MCDOWELLI*) (SERPENTES: PYTHONIDAE)

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Bicephalism has been recorded in the following Australian snakes: *Acanthophis wellsi x Acanthophis pyrrhus/Acanthophis wellsi* hybrid (Maryan, 2001), *Pseudonaja affinis* (Maryan, 2001) and *Morelia spilota mcdowelli* (Hoser & Gibbons, 2003). This note reports a second case involving captive-bred *Morelia spilota mcdowelli*, bred by the second author.

Each of the heads in this animal were separated from one another by a section of neck, which fused some distance down to join a single body (Fig. 1). One head appeared to be normal. The second head was deformed. There was a kink in the neck and only one eye. The snake survived some weeks after birth. All other snakes in the litter were normal.

This case of bicephalism was similar to that previously reported for this species (Hoser & Gibbons, 2003). However, both cases differed markedly from the bicephalism reported in *Acanthophis* (Maryan, 2001). It is not clear whether this is significant.

Bicephalism has been reported frequently in reptiles outside Australia (Hoser & Gibbons, 2003) and is probably more common in Australian species than the limited published records suggest.

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Figure 1. Bicephalic Coastal Carpet Python (Photo: P. Harris).

AN ALBINO HOSMER'S SKINK, *EGERNIA HOSMERI*

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Albinism occurs in many reptiles (Bechtel, 1995). Although it has been reported in the scincid genus *Tiliqua* (Shea & Kent, 1988), we report here what we believe to be the first record of albinism in the closely related scincid genus *Egernia*.

The Adelaide Zoo has had *E. hosmeri* in its collection since 1990, and the species has bred successfully there since 1991 (Post, 2000). To date, 55 offspring have been produced from two breeding groups. These breeding groups were derived from three unrelated founding individuals.

On 7 January 2004, one of our breeding groups produced an albino neonate. Almost pure white with bright red eyes (Figure 1), it was healthy at birth (snout-vent length (SVL) 72 mm, tail length 51 mm, mass 9.5 g). Save its colour, the albino did not differ morpho-

logically in a substantial way from five normally-colored Hosmer's Skinks (Fig. 1) born at Adelaide Zoo since 2000 (mean ± SD; mass = 10.44 g ± 1.795, standard normal deviate P = 0.603; SVL 70 mm ± 4.359, standard normal deviate P = 0.646; tail length = 46.8 mm ± 5.805, standard normal deviate P = 0.472).

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Figure 1. Albinistic (above) and normal (below) *Egernia hosmeri* born at Adelaide Zoo in January 2004.

A MATING AGGREGATION OF KEELBACK, *TROPIDONOPHIS MAIRII*.

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Aggregations are known in a number of Australian snake species, associated in most cases with low activity or aestivation (see Hoser, 1980). Mating aggregations are less commonly recorded. Slip and Shine (1988) record mating aggregations in *Morelia s. spilota*, Shine (1986) documents mating aggregations in *Acrochordus arafurae*, and a photograph of an aggregation of *Tropidonophis mairii* appears in Shine (1991: 110).

On 9 November 2003 at 7:30 pm an aggregation of four *T. mairii* was observed at a roadside retaining wall on Old Mt Samson Rd, Closeburn, south-east Qld, near the corner of Herron Rd (27°19'27"S, 152°51'17"E). The wall is at least 200 m long, 3 m high at its highest and constructed of large sandstone blocks, creating abundant crevices and protected shelters. The wall faces roughly north-west. Other herpetofauna previously observed at the site were *Demansia psammophis, Cryptophis nigrescens, Litoria caerulea* and *Bufo marinus*. Interestingly, no geckos appear to have colonised the wall. *Tropidonophis mairii* were previously recorded at the site on 5 April 2003, 11 April 2003 (2 animals), 2 June 2003 and 12 June 2003.

The weather on the night of 9 November 2003 was warm and clear, with a full moon, after a partly overcast day with early light showers. Two *T. mairii* were seen lying side by side in a horizontal crevice, approximately 1.5 m above ground level and approximately 200 mm back from the outer edge of the rock. When touched the rock was judged to be approximately the same temperature as the air. One individual was larger, with a reddish wash down the body. The other was the steely olive-grey colour common in south-east Qld. A third individual, of similar size and colour to the smaller individual in the crevice, was disturbed in grass at the base of the wall, retreated into a crevice and in a moment was seen moving around the pair.

About 30 minutes later, upon returning to the site, the large reddish individual could be seen in the same position, with one smaller individual lying alongside, another on top, and a fourth small animal resting beside the anterior portion of the other snakes.

This behaviour is interpreted as mating rather than combat as ritual combat typically involves entwining of the bodies. The larger reddish individual is presumed to be a female, as females are known to attain larger sizes than males (Shine, 1991). The frequency which *T. mairii* were observed at the site (spanning summer and winter) suggests the wall is a focal point of activity for the species in the immediate vicinity.

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BOOK REVIEW: A FIELD GUIDE TO REPTILES OF NEW SOUTH WALES

There is something to be said about insider information, the legal variety of course. All three authors of *Field Guide to Reptiles of New South Wales* either work at, or are affiliated with, the Australian Museum where approximately 162 000 herpetological specimens and millions of locality records are housed. In addition, the authors have the ability to access specimens and location information from other museums throughout Australia and the world. The result? An accurate and informative field guide that makes these museum records accessible to all.

A Field Guide to Snakes and Lizards of New South Wales was first published in 1990 and even then was a great, educational, compact field guide. The second edition, now called Field Guide to Reptiles of New South Wales, has an entirely new layout and expands beautifully on the information contained in the first. This expansion is not limited to the obvious inclusion of non-snake and lizard species such as turtles, but also 26 new species, the countless additional locations and numerous name changes that have occurred over the past 14 years.

The guide is set out very logically. Each family is grouped into one of three Orders – lizards, snakes and turtles. For ease of use in the field, each family has a colour-coded tab in the top right corner of the page. These colours are also reflected in the contents page. Species descriptions are succinct. They include description, size, distribution, habitat and habits. The species maps are particularly helpful and include only verifiable location information.

One of the big draws for this book is the fantastic photography. All three authors are avid and accomplished reptile photographers, as are other contributors such as Geoff Swan, John Cann, Hal Cogger and Ken Griffiths. Photographs are detailed and clear and make identification in the field relatively easy.

Remember this book is a compact field guide and as such a lot of information on scalation and colour variations is not included. There will be some species that will be difficult, if not impossible, to identify. However, these will be minimal compared to the multitude you will have fun identifying.

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NOTES TO CONTRIBUTORS

Herpetofauna publishes articles on any aspect of reptiles and amphibians. Articles are invited from interested authors particularly non-professional herpetologists and keepers. Priority is given to articles reporting field work, observations in the field and captive husbandry and breeding.

All material must be original and must not have been published elsewhere.

PUBLICATION POLICY

Authors are responsible for the accuracy of the information presented in any submitted article. Current taxonomic combinations should be used unless the article is itself of a taxonomic nature proposing new combinations or describing new species.

Original illustrations will be returned to the author, if requested, after publication.

SUBMISSION OF MANUSCRIPT

Two copies of the article (including any illustrations) should be submitted. Typewrite or handwrite (neatly) your manuscript in double spacing with a 25mm free margin all round on A4 size paper. Number the pages. Number the illustrations as Figure 1 etc., Table 1 etc., or Map 1 etc., and include a caption with each one. Either underline or italicise scientific names. Use each scientific name in full the first time, (eg *Delma australis*), subsequently it can be shortened (*D. australis*). Include a common name for each species.

The metric system should be used for measurements.

Place the authors name and address under the title.

Latitude and longitude of any localities mentioned should be indicated.

Use the Concise Oxford Dictionary for spelling checks.

Photographs — black and white prints or colour slides are acceptable.

Use a recent issue of Herpetofauna as a style guide.

A computer disc may be submitted instead of hard copy but this should not be done until after the manuscript has been reviewed and the referees' comments incorporated. Computer discs must be HD 1.44 mb 3.5" in Word for Windows; Wordperfect; Macintosh or ASCII. Any disc must also be accompanied by hard copy.

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REFERENCES

Any references made to other published material must be cited in the text, giving the author, year of publication and the page numbers if necessary. At the end of the article a full reference list should be given in alphabetical order. (See this journal).

Manuscripts will be reviewed by up to three referees and acceptance will be decided by an editorial committee. Minor changes suggested by the referees will be incorporated into the article and proofs sent to the senior author for approval.

Significant changes will require the article to be revised and a fresh manuscript submitted.

REPRINTS

The senior author will receive 25 reprints of the article free of charge.

Iridomyrmex conifer nest at Bunkers Bay turnoff, Cape Naturaliste, WA, April 1979 (Photo by Magnus Peterson). See article on page 7.

Male *Notaden bennettii* from south of Condobolin, NSW, calling from water among emergent vegetation. See article on page 25.